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ARITHMETIC

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ARITHMETIC

WITH KEY SEPARATE

For the USE of SCHOOLS and PRIVATE STUDY

BY

MONTAGU H. FOSTER

PRINCIPAL OF STUBBINGTON HOUSE, FAREHAM

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PREFACE.

THE FOLLOWING PAGES have been designed with the object of rapidly advancing a student, and with this view the examples in each rule have been limited to ten, except in Reduction. In order to thoroughly ground a boy, the proofs of the elementary rules are given; and, to test a pupil's knowledge of the rules learnt, papers containing examples on previous rules are added.

ARITHMETIC.

Arithmetic is the science that treats of the nature and use of numbers.

Numbers are represented by figures, and are either concrete or abstract.

The figures are :—

1, one.
2, two.
3, three.
4, four.
5, five.
6, six.
7, seven.
8, eight.
9, nine.

By the use of these, with 0, *nought* or *cypher*, all numbers whatsoever may be represented.

A *unit* denotes *one* individual of its kind ; as *one* pound, *one* hour.

A. A number is said to be *concrete* when it represents some particular kind of unit, as *eight* boys, *nine* cows ; but an *abstract* number is that which has reference to no particular units.

Thus 8 represents 8 units only, without referring to particular objects.

NUMERATION.

Numeration teaches the meaning of figures. A figure standing alone means so many *units*, thus :

5, five units ; 9, nine units.

Several Figures.

When figures are placed together, they have, besides their own value, a value depending on their *place*.

The value of every figure is increased tenfold for every place that it stands to the left of the units' place.

Hundreds of thousands of billions.	Tens of thousands of billions.	Thousands of billions.	Hundreds of billions.	Tens of billions.	Units of billions.	Hundreds of thousands of millions.	Tens of thousands of millions.	Thousands of millions.	Hundreds of millions.	Tens of millions.	Units of millions.	Hundreds of thousands.	Tens of thousands.	Thousands.	Hundreds.	Tens.	Units.
6	5	4	3	2	1	6	5	4	3	2	1	6	5	4	3	2	1

B. That is, if we commence from the right, each period of three will contain units, tens, and hundreds, and each periods of six will contain units, tens, hundreds, thousands, tens of thousands, and hundreds of thousands; each period of six having its one name or value, according to place:

1st, units; 2nd, millions; 3rd, billions; 4th, trillions.

Thus:—

Tr.	B.	M.	U.
Th. u.	Th. u.	Th. u.	Th. u.
271,372	184,217	624,850	217,634.

To numerate any number of figures.

Rule. Divide the figures into periods of three, beginning from the right, and then into periods of six, placing units and thousands over every alternate period of three, and units, millions, billions, trillions, &c., over every period of six, commencing from the right, thus:—

B.	M.	U.
Th. u.	Th. u.	Th. u.
210,001	302,900	005,079.

Ans. Two hundred and ten thousand and one billions, three hundred and two thousand nine hundred millions, five thousand and seventy nine (units).

N.B. The names million, billion, trillion, &c., can only be used once in the same example.

EXAMPLES. I.

Express in words:—

1. 42031.
2. 82003.
3. 10024.
4. 2340000.
5. 721000001.
6. 300010020.
7. 82130010001.
8. 7200000102345.
9. 1000000200178005.
10. 3090908000700700201.

NOTATION.

NOTATION, the converse of Numeration, teaches how to express numbers by figures.

RULE. Place the *units*, the *thousands*, the *millions*, &c., in their respective periods, as laid down above.

C. Thus:—

Express ten billions, four hundred and five millions, ten thousand and forty six, in figures.

B.	M.	U.
Th. u.	Th. u.	Th. u.
.....10	000,405	010,046.

Ans. 10000405010046

EXAMPLES. II.

Express in figures:—

1. Forty thousand and twenty-six.
2. Eighty-one thousand and twenty-two.
3. Nine millions and one.
4. Seventy-nine millions, ten thousand, three hundred and one.

5. One hundred millions.

6. Sixty-five billions, two thousand and one millions, and one.

7. One hundred and five thousand and five millions, twenty-five thousand.

8. Three trillions and three.

9. Eighty trillions, four hundred and one millions.

10. One trillion, one billion, one million and one.

ADDITION.

Addition is the collecting of two or more numbers into one sum.

The sign + signifies addition thus, 7 + 2 means two added to seven.

To add numbers of many figures.

Rule. Set the numbers one under another, placing units under units, tens under tens, hundreds under hundreds, &c.

Draw a line under the columns.

Add up the columns one after another, beginning on the right.

If the sum of any column has more than one figure, set under that column the figure of *lower* place, and carry the figure of *higher* place to the next column; at the last column set down the entire sum.

The sum of the several columns thus placed will be the entire sum.

Ex. Add 768, 975, 864, 891.

Explanation of operation and proof.

768 . .	7 hundreds,	6 tens,	8 units.
975 . .	9 „	7 „	5 „
864 . .	8 „	6 „	4 „
891 . .	8 „	9 „	1 „
3498 . .	32 hundreds,	28 tens,	18 units.

1, 4, 5, and 8 units are 18 units, or 1 ten and 8 units; put 8 in the units' place, and carry 1 to the tens; 1, 9, 6, 7, and

6 tens are 29 tens, put down 9 in the tens' place, and carry 2 hundreds to the hundreds, 2, 8, 8, 9 and 7 hundreds are 34 hundreds, or three thousands and four hundreds, we set down 4 in the hundreds' place, and put 3 in the thousands' place; and the sum is 3 thousands, four hundreds, 9 tens and 8 units, or 3498, as by the rule.

EXAMPLES. III.

Add together :—

1. 123, 234, 521.
2. 312, 428, 976.
3. 4001, 32175, 842.
4. 72034, 5001, 82172031.
5. 821367, 8196, 42173674, 1836, 820417, 831275.
6. 800902, 7219, 99368, 7214500021, 3998792, 52001021.
7. 592310245, 8312456, 270007, 92109356724, 12345679, 100002103, 721349991724, 5621349.
8. 20070540, 768362176, 868735719, 27987997826, 807054, 40802076.
9. 807086954321, 277878024, 876, 27104, 32040, 708050423, 875624, 3078050782, 87038739865, 41526, 898765.
10. 7883, 878389, 76543218, 807876895412, 307, 8789832143, 541, 27689634132.

SUBTRACTION.

SUBTRACTION is taking a less number from a greater.

The sign $-$ signifies subtraction; thus $7-2$ means take 2 from 7.

To subtract numbers of many figures.

RULE. Place the less number under the greater, ranging units under units, tens under tens, &c.

Draw a line beneath the less number.

Find the difference of each column, beginning with that of the units.

If the upper figure in any column be less than the lower, add ten to it, from this sum subtract the lower figure, put down the remainder and carry *one* to the next figure of the lower line. The several differences then set down will be the required difference.

Ex. From 52043 take 36835.

Explanation of operation and proof.

52043 . . 5 tens of thousands, 2 thousands, 0 hundreds, 4 tens, 3 units.
36835 . . 3 ,, 6 ,, 8 ,, 3 ,, 5 ,,

15208 . . 1 tens of thousands, 5 thousands, 2 hundreds, 0 tens, 8 units.

5 units cannot be taken from 3 units, add ten units (taken from 4 tens or 40 units) to 3 units; and 5 units taken from 13 units leave 8 units, put down 8 in the units' place: 3 tens from 3 tens (for the 4 tens with the 1 ten taken from it has become 3 tens) is 0 tens, put 0 in the tens' place: 8 hundreds from 0 hundreds cannot be taken, add 10 hundreds (taken from 2 thousands, or 20 hundreds) and 8 hundreds from 10 hundreds is 2 hundreds, set down 2 in the hundreds' place: 6 thousands from 1 thousand (for the 2 thousands with 1 thousand taken from it has become 1 thousand) cannot be taken, add 10 thousands (taken from the 50 thousands, or 5 tens of thousands) and 6 thousands from 11 thousands is 5 thousands, put 5 in the thousands' place: 3 tens of thousands from 4 tens of thousands is 1 tens of thousands, and the difference is 1 ten of thousands, 5 thousands, 2 hundreds, 0 tens, and 8 units, as by the rule.

EXAMPLES. IV.

From	Take
1. 829.	513.
2. 645.	324.
3. 823.	519.
4. 7021.	3401.
5. 98210.	39217.
6. 2123456.	92197.
7. 7218370.	1293929.
8. 10010001.	999099.
9. 37210345.	8210499.
10. 2460000121.	899791849.

PAPER No. I.

1. Add together 4213, 821756, 4020.
2. From 82107 take 9219.
3. Find the sum of 721, 8420, 730128, and 300012.
4. Find the difference between 721368 and 99901.
5. Find the sum and difference of 8214 and 920001.
6. The English army consists of 272,000 men, and the Russian army of 849,000 men; how many more men have the Russians than the English?
7. Express in words 1209367.
8. Express in figures: twenty-one millions, four thousands, and twenty-six.
9. Add together 7218421, 736214, and 5213458, and take four millions and twenty-six from their sum.
10. How much greater are sixty-four millions than 64000?

MULTIPLICATION.

MULTIPLICATION *is a short way of finding the sum of a number, added any number of times.*

The number to be so added is called the *multiplicand*, the number of times it is to be added, the *multiplier*, and the result, the *product*.

Thus: 2 multiplied by 5.

2 is the multiplicand
5 is the multiplier
and 10 is the product.

The sign × (into) expresses multiplication; thus $2 \times 3 = 6$, means that 2 multiplied by 3 equals 6.

A small figure placed over a number to its right is called an *index*, and means that you are to multiply by that number so many times: thus $4^3 = 4 \times 4 \times 4$, and the result is 64.

The numbers multiplied together are called *factors*; thus in 2×5, 2 and 5 are the factors of 10.

MULTIPLICATION TABLE.

Twice	3 times	4 times	5 times	6 times	7 times
1=2	1=3	1=4	1=5	1=6	1=7
2=4	2=6	2=8	2=10	2=12	2=14
3=6	3=9	3=12	3=15	3=18	3=21
4=8	4=12	4=16	4=20	4=24	4=28
5=10	5=15	5=20	5=25	5=30	5=35
6=12	6=18	6=24	6=30	6=36	6=42
7=14	7=21	7=28	7=35	7=42	7=49
8=16	8=24	8=32	8=40	8=48	8=56
9=18	9=27	9=36	9=45	9=54	9=63
10=20	10=30	10=40	10=50	10=60	10=70
11=22	11=33	11=44	11=55	11=66	11=77
12=24	12=36	12=48	12=60	12=72	12=84

8 times	9 times	10 times	11 times	12 times
1=8	1= 9	1= 10	1= 11	1= 12
2=16	2= 18	2= 20	2= 22	2= 24
3=24	3= 27	3= 30	3= 33	3= 36
4=32	4= 36	4= 40	4= 44	4= 48
5=40	5= 45	5= 50	5= 55	5= 60
6=48	6= 54	6= 60	6= 66	6= 72
7=56	7= 63	7= 70	7= 77	7= 84
8=64	8= 72	8= 80	8= 88	8= 96
9=72	9= 81	9= 90	9= 99	9=108
10=80	10= 90	10=100	10=110	10=120
11=88	11= 99	11=110	11=121	11=132
12=96	12=108	12=120	12=132	12=144

To multiply numbers of many figures.

RULE. Set the multiplier under the multiplicand, units under units, &c.

Multiply each figure of the multiplicand successively by the multiplier, beginning with the units.

If any one of the products be of more than one figure put down the lower figure and carry the higher to the next product.

Ex. Multiply 6257 by 2

Explanation of operation and proof.

6257 . .	6 thousands, 2 hundreds, 5 tens, 7 units
2	2
12514 . .	12 thousands, 4 hundreds, 10 tens, 14 units

Proof. 2 into 7 units is 14 units, or 1 ten and 4 units; put down 4 units and carry 1 ten: 2 into 5 tens gives 10 tens and 1 ten makes 11 tens, or 1 hundred and 1 ten; put down 1 in the tens' place, and carry 1 hundred: 2 into 2 hundreds is 4 hundreds, and 1 hundred makes 5 hundreds; set 5 in the hundreds' place: 2 into 6 thousands is 12 thousands, set 12 in the thousands' place.

Examples. V.

Multiply:

1. 721 by 2.
2. 846 by 5.
3. 7421 by 8.
4. 82105 by 9.
5. 100217 by 10.
6. 121345 by 11.
7. 2100345 by 8.
8. 2106724 by 12.
9. 21903629 by 11.
10. 469910029 by 9.

When the multiplier ends in noughts.

Rule. Multiply by the figures of the multiplier, and place as many noughts to the right of the product as there are noughts in the multiplier.

Ex. 1. Multiply 243 by 20.

```
243
 20
----
4860
```

Proof. 243 × 2 = 486 and 243 × 20 must be 10 times as great, and therefore = 4860, since 0 placed to the right removes each figure one place to the left and increases the number 10 times.

Examples. VI.

Multiply:

1. 217 by 10.
2. 8163 by 20.
3. 89127 by 100.
4. 842001 by 8000.

5. 21030 by 90.
6. 20012 by 800.
7. 21099 by 90000.
8. 21099426 by 11000.
9. 218476 by 1200.
10. 998476 by 900000.

When the multiplier is of many figures.

Rule. Multiply by each figure of the multiplier separately, placing the first figure of each product under the figure you multiply by. Add together the products thus found.

Ex. Multiply 5839 by 756.

```
   5839
    756
   ----
  35034
 29195
40873
-------
4414284
```

Proof. The multiplier is 700 and 50 and 6.

5839 × 6 is 35034
5839 × 50 is 291950
5839 × 700 is 4087300
and the sum 4414284 is the product

N.B. To save trouble, the noughts are, as above, left out in every product, except the first.

Examples. VII.

Multiply: 1. 213 by 21.
2. 847 by 374.
3. 80127 by 301.
4. 56213 by 8001.
5. 72001 by 4213.
6. 679901 by 80503.
7. 2100179 by 40021.
8. 7942706 by 821007.
9. 50001021 by 1000210.
10. 79217643 by 42000012.

When the multiplier is the exact product of two or more numbers.

Rule. **Multiply by the factors in succession.**

Ex. Multiply 3472 by 24.

$$24 = 4 \times 6$$

$$\begin{array}{r} 3472 \\ 4 \\ \hline 13888 \\ 6 \\ \hline 83328 \end{array}$$

Ans. 83328.

Examples. VIII.

Multiply:
1. 3426 by 72.
2. 8765 by 66.
3. 6045 by 45.
4. 8075 by 132.
5. 762416 by 120.
6. 8217 by 4800.
7. 721356 by 144.
8. 6210001 by 1728.
9. 12456 by 1670.
10. 40213 by 24000.

DIVISION.

Division finds the number of times one number is contained in another.

In Division, two numbers are given, that which is to be divided, called the *dividend*, and that which divides, called the *divisor*; the number found by dividing is called the *quotient*.

Ex. Divide 4 by 2.

$$\begin{array}{rr} \text{From} & 4 \\ \text{(1) subtract} & 2 \\ \cline{2-2} \text{from remainder} & 2 \\ \text{(2) subtract} & 2 \\ \cline{2-2} \text{remainder} & 0 \end{array}$$

Similarly 6 divided by 3 is 2, and so on.

In this way a *division table* might be formed; but as division is the converse of multiplication, from the table for the latter we may find the quotients: thus, as $3 \times 7 = 21$, 21 divided by $3 = 7$, and 21 divided by $7 = 3$.

Division is denoted by $\div$: thus $10 \div 5$ means 10 divided by 5; or it is denoted by a line with the dividend above it and the divisor below: thus $\frac{10}{5} = 2$, means, that 10 divided by 5 equals 2.

To divide a number of many figures by a divisor less than 12.

Rule. Place the divisor to the left of the dividend, with a line between them. Divide each figure of the dividend in succession, beginning at the highest.

Set the quotients underneath.

If after dividing any figure, there be a remainder, carry it, as so many tens, to the next figure: divide that sum and set down the quotient as before.

Ex. Divide 7739 by 3.

	Explanation of operation and proof.
3)7739	3)7 thousands, 7 hundreds, 3 tens, 9 units
2579–2 rem.	2 thousands, 5 hundreds, 7 tens, 9 units–2 units rem.

Proof. 7 thousands by 3 is 2 thousands, and 1 thousand over, set down 2 in the thousands' place, and carry 1 thousand or 10 hundreds to 7 hundreds: 17 hundreds by 3 is 5 hundreds and 2 hundreds over, set down 5 in the hundreds' place, and carry 2 hundreds or 20 tens to 3 tens; 23 tens by 3 is 7 tens and 2 tens over, set down 7 in the tens' place and carry 2 tens or 20 units to 9 units; 29 units by 3 is 9 units and 2 units over.

Examples. IX.

Divide:

1. 275242 by 2.
2. 80739 by 3.
3. 624836 by 4.
4. 536785 by 5.

5. 607834 by 7.
6. 8362421 by 9.
7. 307845 by 11.
8. 1002041 by 10.
9. 76865244 by 12.
10. 980030795 by 12.

When the divisor is greater than 12.

Rule. Set down the divisor to the left of the dividend.

See how often the first figure of the divisor is contained in the first, or, if that be not large enough, in the first two or three figures of the dividend, and set the result in the quotient.

Multiply the divisor by this quotient figure. Subtract the product thus found from the dividend.

Proceed with this remainder as a dividend, and so on, till all the figures are brought down.

Ex. Divide 34674378 by 951.

```
951)34674378(36460
    2853
     6144
     5706
      4383
      3804
       5797
       5706
       .918 remainder.
```

Ans. 36460 – 918.

We put 951 to the left of the dividend: 9 is contained 3 times in 34, place 3 in the quotient, multiply the divisor by it, and subtract the product 2853, the remainder is 614: annex 4, the next figure of the dividend. Again, 9 is contained 6 times in 61: place 6 in the quotient and proceed as before. The quotient is 36460 with remainder 918, which may be written $36460\frac{918}{951}$

Proof. The operation at full length would stand thus:

```
951)34674378(30000
    28530000
   951)6144378(6000
       5706000
     951)438378(400
         380400
       951)57978(60
           57060
             918
```

Here we find the first part of the qotient 30000, the product of which and the divisor is 28530000; this taken away leaves 6144378 to be divided by 951, which gives for the quotient 6000, and so on.

Examples. X.

Divide :
1. 10000510 by 86.
2. 89765455 by 65.
3. 10324 by 356.
4. 14965387 by 743.
5. 1457924651 by 1204.
6. 75843639426 by 8593.
7. 327840937575 by 716.
8. 51734631391872 by 807609.
9. 46129276014848 by 720106.
10. 321987653321 by 7766.

Division may often be shortened by using the factors of the divisor.

The remainder will be the sum of the remainders, multiplied by the previous divisors.

Ex. Divide 40543 by 960 by factors.

```
      ⎧  4)40543
960   ⎨ 12)10135–3  ⎫                      3
      ⎩    20)844–7 ⎬ = 4 × 7 =           28
               42–4 ⎭ = 4 × 12 × 4 =     192
                                         ———
                                         223
```

Ans. 42 . . 223 rem.

Proof. Dividing by 4, 40543 is divided into 10135 parcels of 4 each, and 3 remaining, and the 10135 parcels of 4 each are again made into 844 parcels containing 12 parcels of 4 each, or 48 and 7 parcels over, containing 4 each or 28 : the 844 parcels of 48 each are again divided into 42 parcels containing 20 parcels of 48 each, and 4 parcels of 48 each over.

Therefore there are 42 parcels of 960 each, 28 parcels of 48 each, 7 of 4 each, and 3 single ones, *i.e.*, the result 42 is the quotient of 40543 divided by 960, and $(4 \times 12 \times 4) + (7 \times 4) + 3$ or 223 over.

EXAMPLES. XI.

Divide (by factors) :

1. 53648973 by 36.
2. 7014596 by 72.
3. 5130652 by 132.
4. 37250360 by 1080.
5. 59552800 by 1440.
6. 5324604500 by 5600.
7. 87532577 by 1728.
8. 13207503 by 1320.
9. 9156787 by 756.
10. 537689797 by 1296.

If the divisor terminates with cyphers :

Cut off the cyphers from the divisor, and as many figures from the right of the dividend as there are cyphers in the divisor; place the remainder to the left of the figures cut off from the dividend.

Thus, 42762 divided by 7800.

78,00)427,62(5
390
―――
37 *Ans.* 5 and 3762 remainder.

PROOF. Cutting off the two cyphers we divided 7800 by 100, and 42762 is divided by 100 by cutting off the 62; the quotient will therefore not be altered, since *both* divisor and dividend have been divided by the *same* number. The remainder 37 is the result of 42 thousands and 7 hundreds, being divided by 7 thousands and 8 hundreds, and therefore is 3 thousands 7 hundreds, to which, if we add the 62 cut off, we shall have 3 thousands, 7 hundreds, and sixty-two, *i.e.*, 3762.

EXAMPLES. XII.

Divide:
1. 8213 by 20.
2. 726004 by 200.
3. 868642 by 720.
4. 769824 by 86400.
5. 60020704 by 72000.
6. 807040 by 12100.
7. 704207043 by 172000.
8. 30742707 by 90900.
9. 287604975 by 808900.
10. 7562000001 by 825000.

PAPER No. 2.

1. Find the sum of 321, 8021, 73250.
2. Find the difference between 213624 and 990217.
3. Express in words 2135620001.
4. Express in figures, one trillion, one million and five.
5. Multiply 8217 by 3.
6. Multiply 72184 by 321.
7. Divide 427 by 4.
8. Divide 836217 by 800.
9. Divide 7283 by 36, by factors, and write a proof showing the correctness of the remainder.
10. How many times is 28345 contained in 94486?

REDUCTION.

Quantities expressed by numbers are of many names, as 2 *pounds*, 3 *ounces*, 4 *miles*.

Names are distinguished as higher and lower.

MONEY.

The names of English money are four: pound, shilling, penny, farthing. £ marks pounds, *s.* shillings, *d.* pence, *q.* farthings. Thus: £2 13*s.* 3*d.* 3*q.* (or $\frac{3}{4}$), stands for 2 pounds, 13 shillings, 3 pence and 3 farthings.

PENCE TABLE.

d.	*s.*	*d.*	*d.*	*s.*	*d.*
12 =	1	0	84 =	7	0
20 =	1	8	90 =	7	6
24 =	2	0	96 =	8	0
30 =	2	6	100 =	8	4
36 =	3	0	108 =	9	0
40 =	3	4	110 =	9	2
48 =	4	0	120 =	10	0
50 =	4	2	130 =	10	10
60 =	5	0	132 =	11	0
70 =	5	10	140 =	11	8
72 =	6	0	144 =	12	0
80 =	6	8			

POUNDS TABLE.

s.	£	*s.*	*d.*	*s.*	£	*s.*	*d.*
20 =	1	0	0	120 =	6	0	0
30 =	1	10	0	130 =	6	10	0
40 =	2	0	0	140 =	7	0	0
50 =	2	10	0	150 =	7	10	0
60 =	3	0	0	160 =	8	0	0
70 =	3	10	0	170 =	8	10	0
80 =	4	0	0	180 =	9	0	0
90 =	4	10	0	190 =	9	10	0
100 =	5	0	0	200 =	10	0	0
110 =	5	10	0				

MONEY TABLE.

4 farthings make 1 penny (*d*)
12 pence make 1 shilling (*s*)
20 shillings make one pound (£)

1 farthing is written $\frac{1}{4}d$, 2 farthings or a halfpenny $\frac{1}{2}d$, three farthings $\frac{3}{4}d$. A groat = 4*d.*, a crown = 5*s.*, a noble = 6*s.* 8*d.*, an angel = 10*s.*, a mark = 13*s.* 4*d.*, a sovereign = 20*s.*, a guinea = 21*s.*, a moidore = 27*s.*

TABLES OF THE WEIGHTS AND MEASURES.

Measure of Weight.

TROY WEIGHT.

24 grains (grs) = 1 pennyweight (dwt)
20 dwts = 1 ounce (oz)
12 ozs = 1 pound (lb)

Used for gold, silver, jewels, and costly articles.

Particular Weights.

20 grains (grs) = 1 scruple (scr)
3 scr = 1 dram (dr)
8 drs = 1 ounce (oz)

Used by apothecaries in compounding medicines.

a carat = 3⅛ grs.

Used for weighing diamonds.

In gold, mixed with alloy, 22 carats or 18 carats fine, means 22 or 18 parts of pure gold in 24: the former is the old and the latter the new standard.

AVOIRDUPOIS WEIGHT.

16 drams (drs.) = 1 ounce (oz.)
16 ozs. = 1 pound (lb.)
28 lbs. = 1 quarter (qr.)
4 qrs. = 1 hundredweight (cwt.)
20 cwts. = 1 ton
112 lbs. = 1 cwt.: 2240 lbs. = 1 ton.

This weight is used in almost all commercial transactions.

Particular Weights.

14 pounds = 1 stone
6 stone = 1 tod
6½ tod = 1 wey
2 weys = 1 sack
12 sacks = 1 last

Used in the Wool Trade.

Measures of Length.

LINEAL MEASURE.

12 inches (in.) = 1 foot (ft.)
3 ft. = 1 yard (yd.)
$5\frac{1}{2}$ yds. = 1 rod or pole (pl.)
40 pls. = 1 furlong (fur.)
8 fur. = 1 mile (ml.)
$69\frac{1}{15}$ mls. = 1 degree (deg.)
3 mls. = 1 league (lea.)

5280 ft. = 1760 yds. = 1 ml.: 220 yds. = 1 fur. Among mechanics the inch is divided into eighths, by officers of the revenue and by scientific persons it is divided into tenths, hundredths, etc. Formerly it was divided into 12 lines.

Particular Measures of Length.

$2\frac{1}{4}$ inches (in.) = 1 nail (nl.)
4 nls. = 1 quarter (qr.)
4 qrs. = 1 yard (yd.)
5 qrs. = 1 ell English (E.E.)
3 qrs. = 1 ell Flemish (E.F.)
6 qrs. = 1 ell French (E.Fr.)

Used in measuring cloth.

A hand = 4 inches
A fathom = 6 feet
A link = $7\frac{92}{100}$ inches
A chain = 100 links
10 square chains = 1 acre

A chain (100 links) = 66 ft.; 1 ac. (10 sq. chains) = 100000 sq. links.

Surface Measure.

144 square inches (sq. in.) = 1 square foot (sq. ft.)
9 sq. ft. = 1 square yard (sq. yd.)
$30\frac{1}{4}$ sq. yds. = 1 square pole (sq. pl.)
40 sq. pls. = 1 rood (rd.)
4 rds. = 1 acre (ac.)
640 ac. = 1 sq. ml.

Measure of Solidity.

1728 cubic inches (cub. in.) = 1 cubic foot (cub. ft.)
27 cub. ft. = 1 cubic yard (cub. yd.)

A cubic foot of water weighs 1000 ozs. = $62\frac{1}{2}$ lbs.

Measure of Capacity.

4 gills = 1 pint (pt.)
2 pts. = 1 quart (qt.)
4 qts. = 1 gallon (gal.)
2 gals. = 1 peck (pk.)
8 gals. = 1 bushel (bush.)
8 bush. = 1 quarter (qr.)
5 qrs. = 1 load

This is the Imperial Measure for all liquids and most dry goods. The last four names are used for dry goods only.

Particular Measures of Capacity.

3 bushels = 1 sack
12 sacks = 1 chaldron
1 firkin = 9 gallons
1 kilderkin = 18 gallons
1 barrel = 36 gallons
1 hogshead = 54 gallons (of beer)
1 butt = 108 gallons
1 anker = 10 gallons
1 runlet = 18 gallons
1 tierce = 42 gallons
1 hogshead = 63 gallons of wine
1 puncheon = 84 gallons
1 pipe = 126 gallons
1 tun = 2 pipes

The imperial gallon contains 10 lbs. avoirdupois of pure water.

Measure of Time.

60 seconds (sec.) = 1 minute (min.)
60 min. = 1 hour (hr.)
24 hrs. = 1 day (dy.)
7 dys. = 1 week (wk.)
28 dys. = 1 lunar month
28, 29, 30 or 31 dys. = 1 calendar month
365 dys. = 52 wks. = 1 year

Angular Measure.

60 seconds ($''$) = 1 minute ($'$)
$60'$ = 1 degree ($^\circ$)
90° = 1 quadrant
4 quadrants = 1 circumference

Particular Names.

24 sheets of paper = 1 quire
20 quires = 1 ream
2 reams = 1 bundle
5 bundles = 1 bale

RULE I.

To reduce a quantity of a higher name to an equivalent quantity of a lower name.

RULE. Multiply the higher name by the number which shows how many of the lower are contained in one of the higher.

If there be any quantities of the lower name in the given number, add them in at the successive reductions.

Ex. 1. In £5 6*s.* 7¼*d.* how many farthings?

$$\begin{array}{lll}
\pounds & s. & d.\\
5 & 6 & 7\frac{1}{4}\\
\underline{20} & & \\
106s. & & \\
\underline{12} & & \\
1279d. & & \\
\underline{4} & & \\
5117q. & &
\end{array}$$

∴ £5 6*s.* 7¼*d.* = 5117*q.* *Ans.* 5117*q.*

Ex. 2. Reduce 1 lb. 5 ozs. 12 dwts. 13 grs. to grains.

$$\begin{array}{llll}
\text{lb.} & \text{ozs.} & \text{dwts.} & \text{grs.}\\
1 & 5 & 12 & 13\\
\underline{12} & & & \\
17\text{ ozs.} & & & \\
\underline{20} & & & \\
352\text{ dwts.} & & & \\
\underline{24} & & & \\
1421 & & & \\
\underline{704} & & & \\
8461\text{ grs.} & & &
\end{array}$$

∴ 1 lb. 5 ozs. 12 dwts. 13 grs. = 8461 grs. *Ans.* 8461.

Here we multiply by 12, 20, 24: because 12 ozs. = 1 lb.;

20 dwts.=1 oz.: and 24 grs.=1 dwt.; and we add in the 5 ozs. 12 dwts. 13 grs. at the several multiplications.

EXAMPLES. XIII.

Reduce:

1. £71 15*s*. 7½*d*. to farthings.
2. £318 10*s*. 8*d*. to halfpence.
3. £8008 11*s*. to shillings.
4. £728 2*s*. 6*d*. to sixpences.
5. £3075 10*s*. 11¼*d*. to farthings.
6. 8076 tns. 3 cwt. 2 qrs. 10 lbs. to pounds.
7. 2758 lbs. 8 ozs. 12 dwts. 20 grs. to grains.
8. 1300 ozs. 6 drs. 2 scr. 10 grs. to grains.
9. 70 leagues 2 mls. 3 fur. 8 pls. to poles.
10. 8 mls. 2 fur. 20 pls. 5 yds. 2 ft. to feet.
11. 20 ac. 3 rds. 10 pls. 15 sq. yds. 6 sq. ft. to sq. feet.
12. 10 sq. mls. 100 acs. 3 rds. 39 pls to poles.
13. 1285 cub. yds. 13 c. ft. 129 c. in. to cubic inches.
14. 277 moidores 2 florins to pence.
15. £172 to fourpenny pieces.
16. £728 10*s*. to florins, fourpenny pieces, and pence.
17. 1800 mls. to feet.
18. 2000 tons to ounces.
19. 52768 shillings to farthings.
20. 100 leagues to furlongs.

RULE II.

To reduce a quantity of a lower name to an equivalent quantity of a higher name.

RULE. Divide the lower name by the number which shows how many of the lower are contained in one of the higher.

To each quotient annex the remainder, if any, giving to it the name of the quantity from which it arises.

Ex. 2. In 30026 farthings how many pounds?

$$\begin{array}{l} 4\underline{)30026q.} \\ 12\underline{)7506d.}\ 2q. \\ \ \ 20\underline{)625s.}\ 6d. \\ \ \ \ \ \ \ £31\ 5s. \end{array}$$

∴ 30026*q*. = £31 5*s*. 6½*d*. *Ans*. £31 5*s*. 6½*d*.

Ex. 3. Reduce 111111 square yards to acres.

$$
\begin{array}{rl}
 & 111111 \\
 & \underline{4} \\
121\left\{\begin{array}{l} \\ \\ \end{array}\right. & \begin{array}{l} 11)\overline{444444}\text{ qr. yds.} \\ 11)\overline{40404}\ .\ .\ 0 \\ 40)\overline{3673}\text{ pls. }1 \end{array}\left.\begin{array}{l} \\ \\ \end{array}\right\} 11\times 1 = 11\text{ qr. yds.} = 2\tfrac{3}{4}\text{ yds.} \\
 & 4)\overline{91}\text{ rds. }33\text{ pls.} \\
 & \overline{22}\text{ ac. }3\text{ rds.}
\end{array}
$$

∴ 111111 sq. yds. = 22 ac. 3 rds. 33 pls. $2\frac{3}{4}$ sq yds.

Ans. 22 ac. 3 rds. 33 pls. $2\frac{3}{4}$ sq. yds.

Here we reduce the yards to quarter yards and divide by 121, the number of quarters in a perch, and so on.

In some cases Rules I. and II. are both employed.

EXAMPLES XIV.

Reduce:

1. 30 pence to farthings.
2. 24 shillings to pence.
3. 4 pounds to shillings.
4. £6 5*s.* to shillings.
5. £8 5*s.* $6\frac{1}{2}$*d.* to farthings.
6. 7000284 farthings to pounds.
7. 8777274 halfpence to pounds.
8. 207874 groats to florins, crowns, and pounds.
9. 3077787 pence to moidores.
10. 8076263 pence to pounds.
11. 8 tons 3 cwt. 2 qrs. to ounces.
12. 10 cwt. 2 qrs. 24 lbs. to pounds.
13. 27 dys. 15 hrs. 16 min. to minutes.
14. 7082467 pints to hogsheads.
15. 307826 quarts to quarters.
16. 376842 ounces to tons.
17. 774274 grains to pounds.
18. 2068074″ to degrees.
19. 7305424 sq. ft. to acres.
20. 3758623 seconds to years.

PAPER No. 3.

1. Express in words 521000021.
2. From 817213 take 1000210.
3. Multiply 721001 by 21001.
4. Divide 8321 by 810, by factors.
5. Reduce £2 3*s*. 6*d*. to sixpences.
6. Reduce to factors 125, 80, 140, having a factor common to each.
7. Multiply 82134 by 2736 and divide the result by 721000.
8. Reduce £72 5*s*. 6*d*. to fourpenny pieces.
9. How many times must 4213 be added to make 16852?
10. Reduce 1 ml. 20 ft. to feet.

PART II. REDUCTION.

EXAMPLES XV.

Reduce:—

1. 4204*q*. to pence.
2. 8325*q*. to pence.
3. 5624*d*. to shillings.
4. 72036*d*. to shillings.
5. 72108*s*. to pounds.
6. 62174*s*. to pounds.
7. 72184*q*. to shillings.
8. 721036*q*. to pounds.
9. 10210345*d*. to pounds.
10. 12345 ozs. to cwts.
11. 42135 ft. to yards.
12. 72136421 lbs. to tons.
13. 834127352 in. to miles.
14. 82134568 sq. ft. to sq. yards.
15. 92174586 pints to quarters.
16. 9321 half-crowns to pounds.
17. 213645 sixpences to guineas.
18. 562136 fourpenny pieces to florins.
19. 831926 pounds to guineas.

PAPER No. 4.

1. From 82134 take 9213.
2. Multiply 7216 by 84000.
3. Divide 3217 by 125, by factors.
4. Find the difference between thirty billions and nine, and one hundred thousand millions nine hundreds.
5. Henry VI. commenced his reign in 1422, and was dethroned in 1461; how much longer did he reign than Edward IV., who reigned from 1461 to 1483?
6. Reduce 123456 crowns to pounds.
7. A father left to his eldest son 12345602178*q*., and to the younger £10,000; which son had the greater share, and by how much did his share exceed the others'?
8. Find the factors of 840.
9. Reduce 169938 cub. inches to cub. yards.
10. Reduce 4 tons 3 cwt. 3 qrs. 1 lb. to pounds.

ADDITION OF MONEY.

RULE. Set the numbers under each other, farthings under farthings, pence under pence. Find the sum of the several names beginning with the lowest, and reduce each sum to its next highest name.

Set the remainders, if any, under the respective columns, and carry the quotients to the higher names.

Ex. 1. Add together

£14 3*s*. $7\frac{1}{2}$*d*., £160 19*s*. $8\frac{1}{4}$*d*., £12 2*s*. $8\frac{3}{4}$*d*.

£	*s*.	*d*.
14	3	$7\frac{1}{2}$
160	19	$8\frac{1}{4}$
12	2	$8\frac{3}{4}$
187	6	$0\frac{1}{2}$

Ans. £187 6*s*. $0\frac{1}{2}$*d*.

After setting the numbers down, the work is :—3, 1, and 2 farthings are 6 farthings, or 1*d*. and 2 farthings. Set down

½*d.* and carry 1*d.* to the pence column: 1, 8, 8 and 7*d.* are 24 pence, or 2 shillings and 0 pence; set down 0 pence under the pence column and carry 2*s.*: 2, 2, 19, and 3*s.*, are 26*s.*, or £1 and 6*s.*; put down the 6*s.* under the shillings column and carry the £1: 1, 12, 160, and £14 are £187.

Ex. 2. Add together

Tons	cwt.	qrs.	lbs.
35	16	0	20
42	14	2	18
18	9	1	16
17	18	3	7
31	5	3	19
45	12	2	5
191	17	2	1

Ans. 191 tons, 17 cwt. 2 qrs. 1 lb.

Here the sums of the lbs., qrs., and cwts. are severally divided by 28, 4, and 20, the remainders are set down and the quotients carried to the next column.

EXAMPLES. XVI.

Add together

1. £2 3*s.* 4*d.*, £5 10*s.* 6*d.*

2. £8 0*s.* 9½*d.*, £1 5*s.* 6¾*d.*

3. £24 12*s.* 6¾*d.*, £8 9*s.* 9*d.*, £7 5*s.* 0½*d.*

4. £10 10*s.* 10½*d.*, £5 11*s.* 11½*d.*, £100 10*s.* 4*d.*, £84 5*s.* 6½*d.*, £96 1*s.* 4*d.*

5. 2 cwt. 1 qr. 5 lbs., 3 cwt. 2 qrs. 8 lbs.

6. 1 ml. 2 fur. 20 pls. 2 yds., 8 mls. 5 fur. 16 pls. 3 yds.

7. 24 ac. 2 rds. 5 pls., 10 ac. 4 rds. 5 pls. 30 yds., 8 ac. 1 rd. 20 yds.

9. 8 bush. 2 gals. 3 qts. 2 pts., 9 bush. 6 gals. 0 qts. 3 pts., 27 bush. 0 gals. 1 pt.

9. £100, 100*s.* £27, 40 sixpences, 80*d.*, 200*s.* 40*q.*

10. 100 lbs. 4 ozs. 12 dwts. 20 grs., 37 lbs. 3 ozs. 10 dwts. 6 grs., 112 lbs. 8 ozs., 72 lbs. 18 grs., 10 dwts. 18 grs., 72 lbs. 15 dwts.

SUBTRACTION OF MONEY, &c.

Rule. Set the lesser quantity under the greater, farthings under farthings, &c.

Subtract the several names beginning with the lowest.

If in the upper line a name be less than the same name in the lower, add to it as many as make one of the next higher name.

From this sum subtract the name in the lower line. Set down the difference and carry 1 to the next higher name.

Ex. 1. From £176 9*s.* 7½*d.* take £20 19*s.* 3¾*d.*

$$\begin{array}{rrr} 176 & 9 & 7\frac{1}{2} \\ 20 & 19 & 3\frac{3}{4} \\ \hline 155 & 10 & 3\frac{3}{4} \end{array}$$

Ans. £155 10*s.* 3¾*d.*

Proof. When we added 1*d.* to ½*d.* we took it from 7*d.*; which therefore become 6*d.*: now taking 3*d* from 6*d.* is the same as taking 4*d.* from 7*d.*: and so on in the other names.

Examples. XVII.

From	Take
1. £3 5*s.* 6*d.*	£2 1*s.* 4*d.*
2. £8 0*s.* 2½*d.*	£3 9*s.* 4½*d.*
3. £94 8*s.* 9¾*d.*	£76 10*s.* 11½*d.*
4. £102134 0*s.* 0¾*d.*	£82136 8*s.* 9*d.*
5. 2 cwt. 2 qrs. 3 lbs.	1 cwt. 2 qrs. 2 lbs.
6. 9 bush. 3 gals. 1 qt.	4 bush. 8 gal. 2 qts.
7. 90 cub. yds. 20 c. ft. 1280 c. in.	80 cub. yds. 21 c. ft. 96 c. in.
8. £200.	2000*s.*
9. 2000 sixpences,	8200*d.*
10. 20,000 guineas,	£1725.

PAPER No. 5.

1 Express in figures, one billion, two hundred and sixty-seven thousand millions, one hundred and two.

2 Break into factors 108, 288, 8100.

3. Divide 365730 by 1002, and prove the correctness of the work by multiplication.

4. Reduce 24 mls. 8 fur. 20 pls. 3¼ yds. 5 ft. to feet.
5. Reduce 12345678 ozs. to cwts.
6. From £37284 5*s.* 6½*d.* take £36214 0*s.* 9¾*d.*
7. A dealer bought 100 sheep for £250, 35 pigs for £35, 16 oxen for £320, and 5 cows for £51 5*s.*; how many animals did he purchase, and what was his whole outlay?
8. What number multiplied by 300 and having 36 added to its product will amount to 83436?
9. A father having 3 sons, left the eldest £32000, the youngest £27000, and the second £520 less than the youngest; by how much did the share of the eldest exceed that of the second?
10. If I borrowed 700 guineas, what should I owe after paying back £200 5*s.*, and £110 11*s.*?

MULTIPLICATION OF MONEY, &c.

1. *When the multiplier does not exceed* 12.

Rule. Multiply the several names successively, beginning with the lowest.

Reduce each product to its higher name, set down the remainder if any, and carry the quotient to the product of the next higher name.

Ex. 1. Multiply £2 7*s.* 6½*d.* by 5.

£	*s.*	*d.*	
2	7	6½	
		5	
11	17	8½	*Ans.* £11 17*s.* 8½*d.*

Here 5 times 2*q.* are 10*q.* or 2*d.* 2*q.*, set down ½*d.* and carry 2*d.*: 5 times 6*d.* are 30*d.*, which with 2*d.* is 32*d.*, or 2*s.* and 8*d.*, set down 8*d.* and carry 2*s.*: five times 7*s.* are 35*s*: which with 2*s.* is 37*s.* or £1 and 17*s.*, set down 17*s.* and carry £1: 5 times £2 are £10, which with £1 is £11.

Ex. 2. Multiply 33 cwt. 2 qrs. 22 lbs. by 7

cwt.	qrs.	lbs.	
33	2	22	
		7	
235	3	14	*Ans.* 235 cwt. 3 qrs. 14 lbs.

Here the product of the lbs. 154 lbs. is divided by 28 and gives 5 qrs. with remainder 14 lbs.: the product of the qrs., with 5 qrs. added, is 19 qrs. which, divided by 4, gives 4 cwt. with remainder 3 qrs.: the remainders are put down, and the quotients carried.

EXAMPLES. XVIII.

Multiply:

1. £2 4*s.* 8½*d.* by 2.
2. £8 17*s.* 11¾*d.* by 5.
3. 1 ton, 3 cwt. 2 qrs. 10 lbs. by 6.
4. £72 18*s.* 11½*d.* by 8.
5. £100 10*s.* 10*d.* by 11.
6. 7 cub. yds. 13 cub. ft. by 12.
7. 104 mls. 6 fur. 10 pls. by 9.
8. 10 lbs. 8 ozs. 10 dwts. 16 grs. by 12.
9. £1084 19*s.* 11½*d.* by 9.
10. 2 rds. 10 pls. 5½ yds. by 10.

2. *When the multiplier is greater than* 12.

RULE. Multiply the *factors* of the multiplier.

Ex. Multiply 5*s.* 3½*d.* by 15.

	s.	*d.*
	5	3½
		5
1	6	5½
		3
3	19	4½

Ans. £3 19*s.* 4½*d.*

If the multiplier cannot be broken exactly into factors add to the product of the factors of part of it, the upper line multiplied by the remaining part.

Ex. Multiply 5*s.* 3½*d.* by 17.

17 = 3 × 5 + 2

	s.	*d.*
	5	3½ × 2
		5
1	6	5½
		3
3	19	4½
	10	7 = upper line × 2
4	19	11½

Ans. £4 19*s.* 11½*d.*

N.B. The same result would have been obtained had we multiplied by 9 and 2, and subtracted the upper line for 17 = 9 × 2 − 1.

Ex. What is the price of 2485 yards of cloth at 15*s.* 7½*d.* per yd.?

	s.	*d.*		
	15	7½	price of	1 yd
		10		
7	16	3	,,	10 yds.
		10		
78	2	6	,,	100 ,,
		10		
781	5	0	,,	1000 ,,
		2		
1562	10	0	,,	2000 ,,
312	10	0	,,	400 ,,
62	10	0	,,	80 ,,
3	18	1½	,,	5 ,,
1941	8	1½	,,	2485 yds.

Here we find the prices of 10, 100, and 1000 yds. We multiply the price of 1000 by 2, of 100 by 4, of 10 by 8, and of 1 by 5, and hence have the prices of 2000, 400, 80 and 5 yds; the values of these added together gives the value of 2485 yds.

EXAMPLES. XIX.

Multiply:

1. £7 10*s.* 6½*d.* by 32.
2. £10 12*s.* 7*d.* by 47.
3. £18 7*s.* 6¾*d.* by 108.
4. 7 cwt. 2 qrs. 10 lbs. by 98.
5. 30 bush. 2 gals. 3 qts. 1 pt. by 92.
6. 172 tons 8 cwt. 1 qr. by 197.
7. £2045 10*s.* 4½*d.* by 709.
8. £726 13*s.* 6*d.* by 1000.
9. £2 16*s.* 7½*d.* by 2645.
10. 1 cwt. 1 qr. 10 lbs. by 2102.

DIVISION OF MONEY, &c.

Rule. Divide each name successively, beginning at the highest.

Set down the quotient.

Reduce the remainder, if any, to its next lowest name, and add it so reduced to the next lower name in the dividend.

Divide that sum and proceed as before.

Ex. Divide £61 8*s.* 9½*d.* by 4.

```
     £   s.  d.
   4)61  8   9½
   ─────────────
     15  7   2¼ 2q.   Ans. £15 7s. 2¼d.–2q. rem.
```

Here £61 by 4 is £15, and £1 or 20*s.* over; set down £15 and add 20*s.* to 8*s.*: 28*s.* by 4 is 7*s.*, set down 7*s.*: 9*d.* by 4 is 2*d.* and 1*d.* or 4*q.* over, set down 2, and add 4*q.* to 2*q.*: 6*q.* by 4 is 1*q.* and 2*q.* over.

Examples. XX.

Divide:

1. £20 15*s.* 4*d.* by 4.
2. £100 10*s.* 8*d.* by 6.
3. £100 10*s.* 10*d.* by 10.
4. £79 8*s.* 11½*d.* by 11.
5. £278 15*s.* 6¾*d.* by 12.
6. 10 tons, 8 cwt. 2 qrs. by 2.
7. 28 lbs. 8 ozs. 12 dwts. 16 grs. by 6.
8. 110 mls. 3 fur. 8 pls. 5 yds. 2 ft. by 3.
9. 100 dys. 12 hrs. 15 min. 45 sec. by 11.
10. 720 ac. 2 rds. 15 pls. by 7.

2. *When the divisor is greater than* 12.

Rule. Divide by the factors of the divisor, if it can be broken into factors; if not, proceed by long division.

Ex. Divide £59 13*s.* 3½*d.* by 66.

```
         £.   s.   d.
   ⎧ 6)59   13    3½
66 ⎨ ──────────────
   ⎩11)9    18   10½–2q. ⎫
      ──────────────      ⎬ 56q. or 1s. 2d. rem.
            18    0¾–9q. ⎭
                       Ans. 18s. 0¾d.–1s. 2d. rem.
```

Here the remainder after dividing by 6 is 2*q.*, and by 11 the remainder is 9*q.*, and therefore the true remainder is $9 \times 6 + 2 = 56q.$, or 1*s.* 2*d.*

EXAMPLES. XXI.

Divide (by factors):

1. £127 13*s.* 5½*d.* by 24.
2. £108 15*s.* 4*d.* by 36.
3. £70 14*s.* 8*d.* by 72.
4. £110 18*s.* 7¾*d.* by 144.
5. £78 16*s.* 7½*d.* by 132.
6. £118 13*s.* 6*d.* by 120.
7. 10 cwt. 2 qrs. 18 lbs. 5 ozs. by 45.
8. 15 lbs. 8 ozs. 10 dwts. 3 grs. by 84.
9. 10 dys. 15 hrs. 25 min. 32 sec. by 81.
10. 320° 10′ 18″ by 99.

LONG DIVISION.

REDUCE each remainder to the next lower name, and add in any quantities of the same name in the dividend.

Ex. Divide £367 13*s.* 6¾*d.* by 23.

```
        £    s.   d.  £.
    23)367   13   6¾(15
       23
       137
       115
        22
        20
     23)453(19s.
        23
        223
        207
         16
         12
      23)198(8d.
         184
          14
           4
       23)59(½d.
          46
          13
          23
```

Ans. £15 19*s.* 8½*d.*—$\frac{13}{23}$*q.* rem.

We bring the remainder £22 into shillings, and add in 13*s.*: we bring the remainder 16*s.* into pence and add in 6*d.*, we bring the remainder 14*d.* into farthings and add in 3*q.*

Division by 100 or 1000 can be done by pointing off as as many figures as there are cyphers.

Thus:

Divide £234 5*s.* 6*d.* by 100.

```
 £    s. d.
2,34  5  6
  20
------
6,85s.
  12
------
10,26d.
   4
------
1,04q.
```

Ans. £2 6*s.* 10¼*d.* $\frac{1}{125}$.

N.B. If the divisor is 400, 600 &c., divide by the figure that remains after cutting off the cyphers, and proceed as above.

EXAMPLES. XXII.

Divide:

1. £118 4*s.* 6*d.* by 37.
2. £119 19*s.* 11½*d.* by 98.
3. £288 5*s.* 0*d.* by 97.
4. £599 2*s.* 4*d.* by 201.
5. £9846 13*s.* 4*d.* by 5275.
6. £2724 10*s.* 6*d.* by 100.
7. £8027 11*s.* 7*d.* by 600.
8. £2134 15*s.* 6*d.* by 900.
9. 200 tons, 18 cwt. 2 qrs. by 75.
10. 857 mls. 96 yds. 2 ft. by 120.

PAPER No. 6.

1. Reduce 123456789*d.* to guineas.

2. Among how many persons can £20 13*s.* 6*d.* be shared, so as to give £2 8*s.* 6*d.* each?

3. A man purchased at a fair 42 horses at £32 10*s.* each, 108 sheep at £2 5*s.* each, and 8 cows at £16 each; how

much money did he lay out, and what money had he left out of £2000?

4. Multiply £783 8*s.* 9½*d* by 2008.

5. Divide 72131 by 240, by factors.

6. Find the value of 800 sheep at £1 2*s.* 6*d.* per head.

7. How much is spent per annum by a man who spends £2 3*s.* 4*d.* a day?

8. Find the value of 8 ducks at 2*s.* 6*d.* each; 9 turkeys at 10*s.* 6*d.*, and 15 geese at 7*s.* 6*d.* each.

9. There are 100 fir-trees planted in a row 12 ft. 6 in. apart; how far is it from the first to the last?

10. What would be the cost of the postage of 100,000 letters at 1*d.*, and 2,000 foreign letters at 2½*d.*?

PROPORTION.

Proportion is the relation of equality existing between two ratios.

Ratio is the relation of one number to another, and is found by dividing the one by the other.

Thus:

$$2 \text{ is to } 4 \text{ (or } 2 : 4) = \tfrac{2}{4} \text{ or } \tfrac{1}{2}$$

and $2 : 8 :: 3 : 12$ because $\frac{2}{8} = \frac{3}{12}$ *i.e.* $\frac{1}{4} = \frac{1}{4}$.

$$\text{and } 2 = \frac{8 \times 3}{12} = 2$$

$$8 = \frac{2 \times 12}{3} = 8$$

$$3 = \frac{2 \times 12}{8} = 3$$

$$12 = \frac{8 \times 3}{2} = 12$$

$$\text{and } 2 \times 12 = 8 \times 3$$

Examples. XXIII.

Find x in the following:

1. $x : 2 :: 15 : 5$.

2. $6 : x :: 15 : 5$.

3. $6 : 2 :: x : 5$.

4. $6 : 2 :: 15 : x$.
5. $9 : 18 :: x : 4$.
6. $x : 10 :: 6 : 18$.
7. $5 : 20 :: 1 : x$.
8. $6 : 3 :: x : 2$.
9. $x : 7 :: 2 : 10$.
10. $1 : 5 :: 7 : x$.

PAPER No. 7.

1. From 27001236218 take forty-nine millions, one hundred and ninety-nine thousands and thirty-eight.
2. Reduce 7283454 moidores to guineas.
3. How many times is £12 3*s*. 9½*d*. contained in £268 3*s*. 5*d*.?
4. Find the value of x when $7 : x :: 9 : 81$.
5. I bought 100 sheep for £250; what must I sell them at per head to gain £18 15*s*. by my bargain?
6. Two boys ran a race, one made 6 steps a second and the other 7 steps; how far will the one be before the other in two minutes, reckoning each step to average 30 inches?
7. Divide £7283 5*s*. 9½*d*. by 248.
8. Multiply 2431028 by 7214000.
9. Reduce 213758 sq. in. to square yards.
10. Divide £225 among 100 men and 50 women, giving each man twice as much as a woman.

RULE OF THREE.

In this Rule three things are given, and a fourth is to be found, between which and one of the three there shall be the same proportion as there is between the other two. Thus, in the question, if 2lbs. of tea cost 8*s*. how much will 10lbs. cost? Three things are given, viz.: 2lbs., 8*s*., and 10lbs., and a fourth is to be found, viz., the price of 10lbs., this price having the same proportion to 8*s*. that 10lbs. has to 2lbs.

RULE. *For the Statement.*—Of the three given terms put down as the third term that which is of the same name as the one required : in the second term put the greater or less of the other two quantities, according as from the nature of the question the quantity sought should be greater or less than the third term (*i.e.*, if the quantity sought should be greater than the third term, put the greater of the two remaining quantities in the second term, and, if less, then put the less in the second term), put the remaining quantity in the first term.

N.B. In the case of the cost, that of which the cost is required must of necessity be the second term, for if greater the cost will be greater, and, if less, less—also in the case of the amount that can be purchased or sold for a certain sum being required, the sum for which it is to be sold or purchased must be the second term, for if less, the quantity purchased or sold will be less, or, if greater, greater.

For the Operation.—Multiply the second and third terms together, and divide by the first: the quotient will be the quantity required, in the same name as the third term : it may be reduced to a higher name if necessary.

If the quantities be compound reduce the first and second terms to the same name, and the third to the lowest name contained in it : then proceed as above.

Since the second and third terms must always be multiplied together and divided by the first, it is evident that the result would be the same, whether we multiply them first and then divide them, or divide one of them first by the first term.

For if we have to multiply 8 by 12 and then divide by 4, we find resulting—

$$8 \times 12 = 96 \text{ and } 96 \div 4 = 24.$$

Now if we divide the 8 by 4 the result is 2, which mulplied by $12 = 24$.

And if we divide 12 by 4 the result is 3, which multiplied by $8 = 24$.

Thus to shorten the work cancel the first into either the second or the third term, as in the following example, where, having reduced the first and second terms to the same names, we have divided both terms, first by 2 and then by 7.

Ex. If 2 cwt. 3 qrs. 14 lbs. cost £6 14*s.* 2*d.*, what will 12 cwt. 3 qrs. cost?

```
cwt. qrs. lbs.        cwt. qrs.          £.   s.   d.
  2   3   14     :     12   3     ::      6   14   2×2
  4                     4                          10
 11 qrs.               51 qrs.           67    1    8
 28                    28                          10
322 lbs.              408               670   16    8
161                  102                 13    8    4
 23                  1428 lbs.       23)684    5    0(29
                      714                46
                      102               224
                                        207
                                         17
                                          20
                                     23)345(15
                                         23
                                        115
                                        115
                                        ...
```

Ans. £29 15*s.*

EXAMPLES. XXIV.

1. If ten horses cost £500, how many may be purchased for £2000?

2. If I can buy 20 eggs for 2*s.* 6*d.*, how much ought I to pay for 15 eggs?

3. If 10 lbs. of butter cost 15*s.* what would be the value of 27 lbs.?

4. A field of 36 acres is let out for £49 17*s.*; what would be the rent of 42 acres at the same price?

5. If 7 men could perform a certain piece of work in 25 days, how many men would be required to do the same in 35 days?

6. A load of bricks contains 500, how many loads were required to build a wall containing 28,500 bricks.

7. If I borrowed £800 of a friend for six months, for how long a time should I lend him £1200 in return?

8. If 1 cwt. 2 qrs. cost £6 6*s.*, how much must be paid for 3 cwt. 3 qrs.?

9. A person performed a journey of 100 miles in 4 days, when travelling 6 hrs. a day; how long would he have been if he had travelled 8 hrs. a day?

10. Find the value of 24 tons 9 cwts. 3 qrs., when 1 ton 2 cwt. cost £23 2*s.*

11. A town has provisions for 6 weeks, at the rate of 15 ozs. a day for each man, at what rate per day must the provisions be served out, so as to last 9 weeks.

12. A person was made bankrupt when he had effects worth £860; this being divided among his creditors, amounted to 2*s.* 6*d.* in the £. How much did he owe?

13. What weight of lead may be purchased for £24 14*s.* when 5 cwt. 2 qrs. cost £12 14*s.*?

14. If 10 sheep are worth 2 oxen, how many sheep should be given in exchange for 25 oxen?

15. If 25 parcels each containing 3 qrs. 23 lbs. are worth £110 15*s.*, what is the value of 15 parcels, each containing 2 qrs. 12 lbs.

16. A pair of gold candlesticks weighing 2 lbs. 8 ozs. are worth £187; what is the value of an oz. of gold?

17. If a farm of 396 acs. 3 rds. 10 pls. be let for £740 14*s.* 4*d.* a year, what is the rent per acre?

18. If 8 cwt. 3 qrs. 27 lbs. are carried 84 miles 6 fur. for £2 7*s.* 6*d.*, how far could 10 tons 18 cwt. be carried at the same rate?

19. If a train performs a journey of 85 miles in 3 hours 15 minutes, in what time would a train, which performs the same journey in two-thirds of the time, accomplish a distance of 280 miles?

20. If a gentleman paid his secretary £350 per annum, how much ought he to pay him for 227 days?

PAPER No. 8.

1. Dividing a certain number by 321, there resulted 420 for a quotient with a remainder 79. What was the number?

2. Divide 821796 by 125 by factors.

3. Multiply £7 3*s.* 6*d.* by 2708.

4. Reduce 1234567 fourpenny pieces to £.

5. Nine persons spend £24 18*s.* 6*d.* in 6 months, what was the average expenditure of each per month?

6. Find the total weight of a load of goods composed of 10 chairs, each 12 lbs. : 3 tables, each 2 qs. 15 lbs. : 1 chest of drawers, 4 cwt. 1 qr. : 3 carpets, 2 qrs. 8 lbs. each, and sundries, 5 cwt. 2 qrs. 9 lbs.

7. If 1 cwt. 2 qrs. of sugar cost £3 15*s.*, what must be given for 9 cwt. 1 qr. 18 lbs.?

8. If tea is bought at 4*s.* 2*d.* per pound, and sold at 4*s.* 9¾*d*, what would be the gain on 1 cwt.?

9. Find the value of x in the expression :—

$$2 : 12 :: x : 9.$$

10. Find the total value of 27 horses at £40 each, 37 cows at £10 10*s.* each, and 100 sheep at £2 5*s.* each.

MEASURES.

A *measure* is a number which will divide another number without a remainder : thus 3 is a measure of 15.

A *common measure* of two or more numbers, is that number which will divide them all without remainder : the *greatest* number which will do so is the *greatest common measure* : thus of 12, 18, 30, the *common measures* are 2, 3, 6, and the *greatest common measure* is 6.

To find the greatest common measure of two numbers.

Divide the greater by the less, and the divisor by the remainder, and so on until nothing remains. The last divisor is the greatest common measure. If there are more than two numbers, find the greatest common measure of two of the numbers : then that of this common measure, and the third number, and so on.

Ex. Find the G.C.M. of 120, 855 and 370.

120)855(7
840
G.C.M. 15)120(8
120

G.C.M. of the 2 first nos. 15)370(24
30
70
60
10)15(1
10
G.C.M. 5)10(2
10

∴ G.C.M. of 120, 855 and 370 = 5 *Ans.* 5.

EXAMPLES. XXV.

Find the greatest common measure of:

1. 324, 864.
2. 620, 864.
3. 288, 1056.
4. 1080, 1728.
5. 3556 and 3444.
6. 84, 154, 343.
7. 990, 1848, 1188.
8. 168, 312, 456, 264.
9. 1323, 3675, 1029, 441.
10. 880, 1360, 4960, 6912.

MULTIPLES.

A *multiple* of a number is a number which can be divided by it without a remainder: thus 12 is a multiple of 4.

A *common multiple* of two or more numbers is that number which can be divided by them all without remainder: the *least* number which can be so divided is the *least common multiple*: thus 24 and 12 are *common multiples* of 3 and 4, and 12 is the *least* common multiple.

To find the least common multiple of two numbers.

Multiply the two numbers together, and divide their product by their greatest common measure.

Ex. Find the L.C.M. of 420 and 860.

$$\begin{array}{llll} & 420)860(2 & & \\ & \quad\underline{840} & & \\ \text{L.C.M.} & \quad\;\; 20)420(21 & & \\ & \qquad\quad\;\; \underline{40} & & \\ & \qquad\qquad 20 & & \\ & \qquad\qquad 20 & & \end{array}$$

$$\therefore \text{L.C.M.} = \frac{420 \times 860}{20}$$
$$= 21 \times 860$$
$$= 18060$$

Ans. 18060.

To find the least common multiple of three or more numbers.

Range the numbers in a line, rejecting all those contained in any higher number.

Divide by the common factors of any two or more of them.

The product of the divisors and remainders is the least common multiple.

Ex. Find L.C.M. of 6, 8, 12, 20, 24, 25.

$$\begin{array}{rrrrrr} \cancel{6} & \cancel{8} & \cancel{12} & 20 & 24 & 25 \\ & & 4) & \underline{20} & \underline{24} & \underline{25} \\ & & 5) & \underline{5} & \underline{6} & \underline{25} \\ & & & 1 & 6 & 5 \end{array}$$

$$\therefore \text{L.C.M.} = 4 \times 5 \times 6 \times 5$$
$$= 600$$

Ans. 600.

EXAMPLES. XXVI.

Find the least common multiple of :—

1. 285, 465.
2. 2931, 27450
3. 990, 1848.
4. 4, 6, 8, 12.

5. 7, 14, 28, 35, 76.
6. 36, 45, 84, 76, 24, 98.
7. 28, 20, 35, 45, 49, 120.
8. 60, 70, 80, 240, 210.
9. 4, 12, 20, 7, 14, 28, 35, 65.
10. 18, 12, 36, 46, 50, 75, 100.

PAPER No. 9.

1. Express in words 700001207489001.
2. Reduce 17592846 inches to miles.
3. Multiply £10 3*s.* $6\frac{1}{2}$*d.* by 2017.
4. If 8 cwt. 2 qrs. of tea cost £89 5*s.*, how much may be purchased for £267 15*s.*?
5. I borrowed 500 guineas; how much do I owe, after paying £390 6*s.* $7\frac{3}{4}$*d.*?
6. Find by inspection the greatest common measure of 12, 15 and 18.
7. Find the greatest common measure of 2145 and 3471.
8. Find the least common measure of 532 and 1274.
9. Find the least common measure of 8, 10, 12, 30, 80, 142.
10. Find the least common measure of 24, 200, 360, 155, 990.

FRACTIONS.

A *fraction* is a part or parts of a unit, as $\frac{3}{4}$. The *lower* number is called the *denominator*, as giving name to the fraction, and shows into how many parts the unit is divided: the *upper* number, called the *numerator*, shows the *number* of such parts taken; thus $\frac{2}{3}$ of 1*s.* means that 1*s.* is divided into three parts, and that two such parts are taken, and therefore equals 8*d.*

A *proper* fraction is one whose numerator is less than its denominator, as $\frac{1}{6}$, $\frac{2}{3}$.

An *improper* fraction is one whose numerator is equal to or greater than its denominator, as $\frac{2}{2}$, $\frac{7}{2}$, and is called improper because it is not really a fraction, but a whole number in a fractional form.

A *mixed number* is composed of a whole number and a fraction, as $1\frac{1}{6}$, $5\frac{3}{9}$.

A *compound fraction* is a fraction of a fraction, as $\frac{2}{3}$ of $\frac{1}{2}$.

A fraction is multiplied by a whole number either by multiplying the numerator, or dividing the denominator by that number.

Ex.

$$\frac{2}{4} \times 2 = \frac{4}{4} \text{ or } 1$$
$$\frac{2}{4} \times 2 = \frac{2}{2} \text{ or } 1$$

A fraction is divided by a whole number either by multiplying the denominator, or dividing the numerator by it.

Ex.

$$\frac{2}{4} \div 2 = \frac{2}{8} = \frac{1}{4}$$
$$\frac{2}{4} \div 2 = \frac{1}{4}$$

The numerator and denominator of a fraction may be both multiplied by, or both divided by any number, without altering the value of the fraction.

Ex.

$$\frac{2}{8} \times \frac{2}{2} = \frac{4}{16} = \frac{1}{4}$$
$$\frac{2}{8} \div \frac{2}{2} = \frac{1}{4}$$

CASE I.

To reduce a fraction to its lowest terms.

Divide the numerator and denominator by their greatest common measure.

Ex. Reduce $\frac{4250}{8450}$ to its L.T.

$\frac{4250}{8540}$ G.C.M. = 50.

```
50)4250(85                      50)8450(169
   400                             50
   ---                             ---
    250                            345
    250                            300
                                   ---
                                    450
                                    450
```

$$\therefore \frac{4250}{8450} = \frac{85}{169} \text{ L.T.}$$

EXAMPLES. XXVII.

Reduce to their lowest terms :—

1. $\frac{35}{42}$.
2. $\frac{208}{684}$.
3. $\frac{171}{1440}$.
4. $\frac{775}{1800}$.
5. $\frac{3094}{3042}$.
6. $\frac{3723}{46320}$.
7. $\frac{5170}{8735}$.
8. $\frac{5565}{8533}$.
9. $\frac{285714}{999999}$.
10. $\frac{135795}{222210}$.

CASE II.

To express a whole number by an equivalent with a given denominator.

Multiply the whole number by the proposed denominator, which also place under the product.

Ex. Express 5 as a fraction whose denominator is 4.

$5 = \frac{5\times4}{4} = \frac{20}{4}$ *Ans.* $\frac{20}{4}$.

EXAMPLES. XXVIII.

Express :

1. 3 by a fraction whose denominator is 4.
2. 7 ” ” 10.
3. 8 ” ” 11.
4. 10 ” ” 20.
5. 6 ” ” 24.
6. 18 ” ” 3.
7. 7 ” ” 25.
8. 11 ” ” 13.
9. 16 ” ” 15.
10. 24 ” ” 34.

CASE III.

To reduce a mixed number to an improper fraction.

Multiply the whole number by the denominator, and to the product add the numerator: under this sum place the denominator.

Ex. Reduce $3\frac{4}{5}$ to an improper fraction.

$3\frac{4}{5} = \frac{3\times5+4}{5} = \frac{15+4}{5} = \frac{19}{15}$ *Ans.* $\frac{19}{15}$.

EXAMPLES. XXIX.

Reduce to improper fractions :—

1. $6\frac{4}{5}$.
2. $8\frac{7}{9}$.
3. $16\frac{3}{4}$.
4. $10\frac{7}{8}$.
5. $15\frac{12}{17}$.
6. $20\frac{4}{5}$.
7. $32\frac{25}{30}$.
8. $234\frac{1}{4}$.
9. $763\frac{17}{25}$.
10. $1008\frac{3\text{[illegible]}}{11}$.

CASE IV.

To reduce an improper fraction to a whole or mixed number.

Divide the numerator by the denominator, the quotient will be the whole number required; and if there be any remainder, place it over the denominator for the fractional part.

Ex. Reduce $\frac{981}{16}$ to a mixed number.

$$\begin{array}{l} 16)981(61 \\ \underline{96} \\ 21 \\ \underline{16} \\ 5 \end{array}$$

$\therefore \frac{981}{16} = 61\frac{5}{16}$. *Ans.* $61\frac{5}{16}$.

EXAMPLES. XXX.

Reduce to mixed quantities or whole numbers

1. $\frac{240}{36}$.
2. $\frac{278}{56}$.
3. $\frac{5600}{28}$.
4. $\frac{8421}{375}$.
5. $\frac{64021}{830}$.
6. $\frac{8420}{421}$.
7. $\frac{98472}{8374}$.
8. $\frac{72145}{2001}$.
9. $\frac{72183}{8219}$.
10. $\frac{1123480}{27936}$.

PAPER No. 10.

1. Express in words $724\frac{64}{107}$.

2. Reduce 72 mls. 3 fur. 24 pls. 1 yd. 2 ft. to inches.

3. What is the length of the 21st of December, the shortest day, when the sun rises at 8hrs. 6 min., and sets at 3hrs. 50 min. ?

4. If a gentleman's income be £500 a year, and he spends 19*s*. 4*d*. a day, how much will he spend in one year ?

5. Find the G. C. M. of 888 and 2775.

6. Find the L. C. M. of 18, 25, 45, 81 and 360.

7. Reduce $\frac{3872}{92807}$ to its lowest terms.

8. Express 7 as a fraction whose denominator is 12.

9. Reduce $234\frac{7}{9}$ to an improper fraction.

10. Reduce $\frac{721840}{62317}$ to a mixed number.

CASE V.

To reduce fractions to others of equal value having a common denominator.

Find the least common multiple of all the denominators: then see what the denominator of each fraction must be multiplied by to produce that number, and multiply the numerator and the denominator by it.

Ex. Reduce $\frac{1}{6}, \frac{5}{12}, \frac{6}{16}$, to L.C.D.

$\frac{1}{6}, \frac{5}{12}, \frac{6}{16}$, L.C.M. = 48.

$\frac{8}{48}, \frac{20}{48}, \frac{18}{48}$. *Ans.* $\frac{8}{48}, \frac{20}{48}, \frac{18}{48}$.

EXAMPLES. XXXI.

Reduce to equivalent fractions with least common denominators :—

1. $\frac{4}{10}, \frac{5}{15}$.
2. $\frac{3}{11}, \frac{5}{12}, \frac{1}{6}$.
3. $\frac{3}{8}, \frac{9}{20}, \frac{13}{24}$.
4. $\frac{7}{9}, \frac{3}{11}, \frac{7}{16}, \frac{5}{32}$.
5. $\frac{1}{4}, \frac{2}{5}, \frac{3}{10}, \frac{7}{12}, \frac{13}{15}$.
6. $\frac{7}{9}, \frac{3}{16}, \frac{15}{17}, \frac{1}{48}, \frac{7}{81}$.
7. $\frac{28}{33}, \frac{43}{1100}, \frac{47}{820}$.
8. $\frac{5}{19}, \frac{2}{21}, \frac{7}{32}, \frac{8}{35}, \frac{11}{140}$.
9. $\frac{7}{2450}, \frac{273}{8500}, \frac{721}{4500}$.
10. $\frac{83}{724}, \frac{45}{7294}, \frac{876}{217200}$.

CASE VI.

To reduce a compound fraction to a simple one.

Mixed numbers must be brought to improper fractions.

Multiply the numerators together for a new numerator, and the denominator for a new denominator.

This work is much shortened by striking out factors common to both numerator and denominator where such are found. Thus :

$$\frac{2}{9} \text{ of } \frac{9}{22} \text{ of } \frac{11}{12} = \frac{2\times 9\times 11}{9\times 22\times 12}$$

$$= \frac{1\times 1\times 1}{1\times 1\times 12}$$

$$= \frac{1}{12}$$

Ans. $\frac{1}{12}$.

EXAMPLES. XXXII.

Reduce to their equivalent simple fractions.

1. $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{6}{7}$ of $\frac{14}{17}$.
2. $\frac{2}{3}$ of $\frac{1}{4}$ of $\frac{1}{2}$ of $\frac{7}{11}$ of $\frac{22}{35}$.
3. $\frac{8}{9}$ of $7\frac{2}{5}$ of $\frac{1}{8}$.
4. $6\frac{1}{4}$ of $\frac{2}{3}$ of $\frac{7}{9}$ of $\frac{8}{5}$.
5. $\frac{2}{3}$ of $\frac{9}{10}$ of $\frac{1}{4}$ of $\frac{1}{5}$ of $\frac{8}{11}$.
6. $\frac{7}{9}$ of $2\frac{1}{2}$ of $3\frac{1}{4}$, of $2\frac{7}{11}$.
7. $\frac{7}{15}$ of $7\frac{11}{20}$ of $84\frac{2}{3}$.
8. $9\frac{1}{9}$ of $22\frac{1}{3}$ of $15\frac{14}{33}$.
9. $\frac{1}{2}$ of $\frac{2}{3}$ of $\frac{7}{9}$ of 4 of $\frac{3}{5}$.
10. $\frac{2}{3}$ of 11 of $5\frac{1}{9}$ of $360\frac{1}{8}$.

PAPER No. 11.

1. What number divided by 74 will give 47 for a quotient, with a remainder 63 ?

2. Reduce 28 yds. 3 qrs. 3 nls. to inches.

3. How much will 149 lbs. of coffee cost at $7\frac{3}{4}d.$ per lb. ?

4 Two men set out to walk; one walked 25 miles 4 fur. 10 pls.; the other did not go so far by $7\frac{3}{4}$ miles; how far did the second man walk ?

5. Find x when $6 : x :: 12 : 32$.

6. Reduce $\frac{6409}{73950}$ to its lowest terms.

7. Reduce $84\frac{7}{27}$ to an improper fraction.

8. Reduce $\frac{847560}{37181}$ to a mixed number.

9. Reduce to equivalent fractions with least common denominators

$$\frac{7}{12}, \frac{3}{11}, \frac{9}{20}, \frac{8}{35}.$$

10. Reduce the following to a simple fraction

$$2\frac{1}{3} \text{ of } 3\frac{1}{9} \text{ of } \frac{4}{7} \text{ of } \frac{21}{40}.$$

CASE VII.

ADDITION OF FRACTIONS.

RID the example of compound quantities. Reduce the fractions if necessary to a common denominator; add together the numerators, and under their sum place the common denominator. Mixed numbers must never be reduced to improper fractions, but added, by adding the fractional parts, and to their sum annexing the sum of the integral parts.

Ex. Add $4\frac{2}{3}$ and $1\frac{1}{6}$ of $\frac{3}{4}$.

$$\begin{aligned} 4\tfrac{2}{3} + 1\tfrac{1}{6} \text{ of } \tfrac{3}{4} &= 4\tfrac{2}{3} + \tfrac{7}{6} \times \tfrac{3}{4} \\ &= 4\tfrac{2}{3} + \tfrac{7}{8} \text{ L.C.D.} = 24 \\ &= 4\tfrac{16}{24} + \tfrac{21}{24} \\ &= 4\tfrac{37}{24} \text{ or } 5\tfrac{13}{24}. \end{aligned}$$

Ans. $5\frac{13}{24}$.

EXAMPLES. XXXIII.

Add together

1. $\frac{7}{8}$, $\frac{6}{13}$.
2. $\frac{4}{5}$, $\frac{7}{10}$, $\frac{8}{15}$.
3. $8\frac{1}{7}$, $6\frac{3}{7}$.
4. $8\frac{2}{3}$, $4\frac{1}{5}$, $3\frac{2}{9}$.
5. $\frac{2}{3}$ of $\frac{3}{7}$, $\frac{1}{9}$ of $4\frac{3}{5}$.
6. $2\frac{1}{2}$, $\frac{3}{7}$ of $\frac{2}{3}$, $5\frac{1}{9}$.
7. $4\frac{1}{2}$, $1\frac{1}{2}$ of $7\frac{1}{8}$, $5\frac{2}{3}$.
8. $\frac{1}{2}$ of $2\frac{1}{3}$ of $4\frac{1}{6}$, $8\frac{1}{2}$, $\frac{1}{3}$ of $\frac{2}{3}$.
9. $74\frac{1}{5}$, $\frac{2}{11}$, $\frac{3}{8}$, $\frac{5}{16}$, $1\frac{1}{22}$.
10. $7\frac{1}{2}$ of $3\frac{1}{4}$ of $\frac{5}{6}$, $\frac{8}{9}$ of $2\frac{1}{4}$ of $\frac{16}{17}$.

CASE VIII.

SUBTRACTION OF FRACTIONS.

REDUCE the fraction as in Addition, subtract the numerators and under their difference place the common denominator.

Mixed numbers must never be reduced to improper fractions, but subtracted by subtracting the fractions, and to their difference annexing the difference of the integral part.

If the fraction to be subtracted be greater than the fraction it is to be taken from, the latter must be increased by borrowing 1 from its integral part.

EXAMPLES. XXXIV.

Subtract

1. $\frac{3}{7}$, $\frac{5}{14}$.
2. $\frac{3}{11}$, $\frac{1}{22}$.
3. $8\frac{1}{22}$, $\frac{3}{11}$.
4. $6\frac{5}{14}$, $4\frac{3}{7}$.
5. $6\frac{7}{9}$, $\frac{1}{2}$ of $\frac{2}{5}$.
6. $\frac{1}{3}$ of $\frac{24}{27}$, $\frac{1}{4}$ of $\frac{1}{5}$ of $2\frac{1}{2}$.
7. $7\frac{1}{9}$, $\frac{2}{3}$ of $\frac{7}{5}$.
8. $240\frac{79}{84}$, $162\frac{43}{1080}$.
9. $7\frac{1}{3}+2\frac{1}{6}$, $7\frac{1}{3}$ of $\frac{3}{8}$.
10. $2\frac{1}{3}+\frac{1}{4}$ of $\frac{1}{5}$, $1\frac{1}{5}+\frac{2}{3}$ of $\frac{5}{8}$.

PAPER No. 12.

1. Divide 38217450 by 827000.

2. From 281 lea. 1 ml. 7 fur. 26 pls. take 82 lea. 2 mls. 5 fur. 39 pls.

3. From a field of $6\frac{1}{2}$ acres I take out three pieces, one measuring $4\frac{1}{2}$ roods, another $2\frac{1}{4}$, and a third 1 rood 12 perches: what is after this the size of the field?

4. Find a quarter's rent of 500 acres of land, which is let at £2 15*s.* 6*d.* per acre per annum.

5. A man who owes £2348, pays 12*s.* $9\frac{1}{2}$*d.* for every pound that he owes: how much does he pay in all?

6. Find the least common multiple of 18, 36, 24, 48, 96, and 108.

7. Reduce $84\frac{721}{867}$ to an improper fraction.

8. Reduce $\frac{247108}{477}$ to a mixed quantity.

9. Add together $4\frac{2}{3}$, $7\frac{1}{9}$, $5\frac{3}{10}$.

10. From $19\frac{1}{7}$ take $7\frac{2}{3}$.

CASE IX.

MULTIPLICATION OF FRACTIONS.

Reduce mixed numbers to improper fractions. Multiply the numerators together for a new numerator, and the denominators for a new denominator.

Ex. Multiply $2\frac{2}{3}$ by $\frac{1}{4}$ of $\frac{3}{5}$ of $\frac{5}{6}$.

$$2\frac{2}{3} \times \frac{1}{4} \text{ of } \frac{3}{5} \text{ of } \frac{5}{6} = \frac{8}{3} \times \frac{1}{4} \times \frac{3}{5} \times \frac{5}{6}$$
$$= \frac{1 \times 1 \times 1 \times 1}{1 \times 1 \times 1 \times 3}$$
$$= \frac{1}{3}$$

Ans. $\frac{1}{3}$.

EXAMPLES. XXXV.

Multiply together

1. $\frac{7}{15}$, $\frac{8}{19}$.
2. $\frac{8}{17}$, $\frac{11}{16}$.
3. $4\frac{1}{3}$, $\frac{1}{5}$.
4. $\frac{1}{5}$ of $\frac{3}{4}$, $2\frac{1}{3}$ of $7\frac{1}{9}$.
5. $2\frac{1}{2}$ of $4\frac{2}{3}$, $\frac{1}{9}$ of $\frac{3}{11}$.
6. $\frac{1}{2}$ of $\frac{3}{4}$ of $\frac{5}{8}$, $2\frac{1}{7}$ of $7\frac{4}{9}$.
7. $5\frac{1}{2}+2\frac{1}{3}$, $\frac{1}{4}$ of $3\frac{1}{5}$.
8. $7\frac{1}{2}+8\frac{2}{9}$, $4\frac{4}{7}-1\frac{1}{6}$.
9. $\frac{1}{5}$ of $\frac{3}{4}$, $2\frac{7}{9}$ of $1\frac{1}{2}$, $4\frac{1}{4}-3\frac{1}{5}$.
10. $\frac{1}{7}$ of $2\frac{1}{8}$, $2\frac{1}{7}+3\frac{1}{4}$, $3\frac{1}{4}-2\frac{1}{7}$.

CASE X.

DIVISION OF FRACTIONS.

Invert the divisor, and proceed as in multiplication.

EXAMPLES. XXXVI.

Divide

1. $\frac{2}{4}$ by $\frac{7}{9}$.
2. $\frac{3}{4}$ by $\frac{8}{9}$.
3. $2\frac{1}{4}$ by $\frac{7}{6}$.
4. $7\frac{1}{9}$ by $1\frac{1}{8}$.
5. $\frac{1}{5}$ of $\frac{3}{7}$ by $2\frac{1}{9}$.
6. $2\frac{1}{4}$ of $\frac{5}{7}$ by $3\frac{1}{6}$ of $\frac{7}{19}$.
7. $4\frac{1}{5}$ by $920\frac{745}{2000}$.
8. $7\frac{1}{9}+4\frac{2}{5}$ by $7\frac{1}{9}-4\frac{2}{5}$.
9. $1\frac{1}{2}\times7\frac{1}{4}$ by $1\frac{1}{2}+7\frac{1}{4}$ by $7\frac{1}{4}-1\frac{1}{2}$.
10. $7\frac{1}{9}-2\frac{7}{9}$ by $\frac{1}{2}+\frac{1}{3}$ of $\frac{5}{9}$ by $\frac{1}{2}$ of $\frac{1}{3}+\frac{5}{9}$.

PAPER No. 13.

1. Express in figures one trillion, two hundred and three thousand millions and one.

2. How many lessons, of 95 lines each, are there in Virgil's Æneid, the number of lines in that poem being nine thousand eight hundred and ninety two.

3. Divide £72456784 3*s*. $6\frac{1}{2}$*d*. by 274.

4. From 19 yds. take 3 qrs. 2 nls. 2 in.
5. Reduce $\frac{3872}{3556}$ to its lowest terms.
6. Add together $720\frac{1}{7}$, $42\frac{7}{8}$, and $\frac{1}{4}$ of $\frac{7}{9}$.
7. Multiply $4\frac{1}{5}$ of $2\frac{1}{3}$ by $4\frac{1}{5}+2\frac{1}{3}$.
8. Divide $28\frac{1}{5}$ by $\frac{1}{4}$ of $\frac{3}{7}$.
9. Five boys had each $\frac{3}{10}$ of an orange: how many oranges had they altogether?
10. How many pieces each $\frac{5}{9}$ of a foot square can I cut out of 20 square feet of cloth?

Case XI.

To find what fraction one quantity is of another.

Reduce the quantities to the same denomination, and place the quantity to which fraction the other quantity is to be brought as the denominator, and the other quantity as the numerator.

Ex. Reduce £7 3*s.* 6*d.* to the fraction of £8 5*s.* 6½*d.*

£7 3*s.* 6*d.* is $\dfrac{\text{£}7\ 3s.\ 6d.}{\text{£}8\ 5s.\ 6\frac{1}{2}d.}$ of £8 5*s.* 6½*d.*

£	*s.*	*d.*	£	*s.*	*d.*
7	3	6	8	5	6½
20			20		
143*s.*			165*s.*		
12			12		
1722*d.*			1986*d.*		
2			2		
3444 halfpence			3973 halfpence		

∴ £7 3*s.* 6*d.* is $\frac{3444}{3973}$ of £8 5*s.* 6½*d.* *Ans.* $\frac{3444}{3973}$.

Examples. XXXVII.

1. What fraction of £1 3*s.* 6*d.* is 2*s.* 6*d.*?
2. What fraction is £7 2*s.* 9*d.* of £8 9*s.*?
3. Reduce 7*s.* 9½*d.* to the fraction of £1.
4. What part of 10 ac. is 2 rds. 4 pls.?
5. Reduce £$\frac{5}{8}$ to the fraction of 18*s.* 6*d.*
6. Reduce 3 fur. 18 pls. to the fraction of half a mile.
7. If one farm contains 37 ac. 2 rds. 14 pls., and another

168 ac. 0 rds. 28 pls., what fraction is the former of the latter ?

8. What fraction of $\frac{1}{2}$ of $\frac{2}{3}$ of £23 is $\frac{1}{9}$ of £2 3*s*. 9*d*. ?

9. Reduce £$\frac{3}{7}$ to the fraction of $\frac{7}{8}$ of £10 3*s*. 6*d*.

10. What part of £3 is $\frac{1}{2}$ of $\frac{3}{5}$ of $2\frac{1}{2}$ of three half-crowns ?

CASE XII.

To find the value of the fraction of any given quantity.

RULE.—Multiply the quantity by the numerator of the fraction, and divide by the denominator.

Ex. Find the value of $\frac{3}{7}$ of £21 7*s*. 7*d*.

$$\begin{array}{r|rrr}
 & £ & s. & d. \\
 & 21 & 7 & 7 \\
 & & & 3 \\
\hline
7) & 64 & 2 & 9 \\
\hline
 & 9 & 3 & 3
\end{array}$$

$\therefore$ $\frac{3}{7}$ of £21 7*s*. 7*d*. = £9 3*s*. 3*d*. *Ans*. £9 3*s*. 3*d*.

EXAMPLES. XXXVIII.

Find the value of :

1. $\frac{3}{7}$ of a guinea.
2. $\frac{2}{9}$ of £4 4*s*.
3. $\frac{4}{5}$ of a mile.
4. $\frac{3}{7}$ of £4 3*s*. $6\frac{1}{2}$*d*.
5. $\frac{1}{2}$ of $\frac{3}{7}$ of $\frac{14}{33}$ of £8 2*s*. 6*d*.
6. $(\frac{3}{4}+\frac{2}{3})$ of £$7\frac{1}{2}$.
7. $\frac{3}{8}$ of £1 + $\frac{1}{8}$ of £10.
8. $\frac{1}{14}$ of $\frac{7}{8}$ of $2\frac{1}{3}$ of £3 5*s*. 6*d*.
9. $2\frac{1}{7}$ of 3 cwt. 2 qrs. 14 lbs.
10. $2\frac{1}{5}$ of a field measuring 44 ac. 2 rds. 5 pls.

RULE OF THREE IN FRACTIONS.

The statement and operation are the same as in whole numbers, but the terms are reduced, multiplied, and divided by the rules for fractions.

EXAMPLES.

1. If $\frac{1}{2}$ of 1 cwt. cost £5, what is the value of $\frac{3}{4}$ of 1 cwt.?

2. If the value of the fourth of a mine is £24864, what is the value of $\frac{3}{8}$ of it?

3. If $\frac{7}{8}$ lb. cost $\frac{13}{14}$*s.* what will $2\frac{11}{12}$ cwt. cost?

4. If sugar can be bought at £81 14*s.* 3*d.* for 9 cwt., what would be the value of $9\frac{1}{2}$ cwt.?

5. How much wine may be bought for £17 8*s.* 4*d.* if $5\frac{5}{11}$ gals. cost £7 7*s.* 6*d.*?

6. If £$\frac{8}{9}$ purchase $1\frac{5}{6}$ lbs. of indigo, how much may be bought for $\frac{16}{19}$*s.*?

7. If $\frac{3}{8}$ of a mill be worth $\frac{7}{8}$ of a ship, what portion of the mill would half the ship be worth?

8. If $\frac{1}{2}$ of $\frac{3}{4}$ of an estate be worth £8000, what is the value of the whole?

9. If the yearly rent of 45 ac. 2 rds. 20 pls. be £$44\frac{7}{16}$, what is the rent of $1\frac{5}{8}$ ac.?

10. If $\frac{1}{9}$ of $2\frac{1}{4}$ of 5 cwt. 2 qrs. of sugar is worth £11, what would be the value of $7\frac{1}{2}$ cwt.?

PAPER No. 14.

1. Express in words $724\frac{7}{25}$.
2. Reduce to a mixed number $\frac{217456}{20081}$.
3. From $8\frac{1}{7}$ take $5\frac{2}{3}$.
4. Find the value of $\frac{1}{2}-\frac{1}{3}+\frac{1}{4}-\frac{1}{5}+\frac{1}{3}$.
5. Simplify $\frac{3}{7}$ of $4\frac{2}{3}$ of $8\frac{1}{9}$.
6. Simplify $\dfrac{5\frac{2}{9}+2\frac{1}{3}}{3\frac{4}{7}-1\frac{1}{2}}$.
7. Find the value of £$\frac{1}{7}$ + $\frac{2}{9}$*s.* + $\frac{5}{12}$*d.*

8. Find the value of $\frac{3}{8}$ of £24 16*s.* 8*d.*, and reduce the result to the fraction of $\frac{1}{5}$ of £3 15*s.*

9. Express as a fraction of £5, the difference between £$7\frac{4}{5}$ and £7 × $\frac{4}{5}$.

10. If $\frac{3}{16}$ of a lottery ticket cost £4 10*s.*, what is the value of $\frac{1}{5}$ of a ticket?

PAPER No. 15.

1. Reduce $72\frac{5}{11}$ to an improper fraction.
2. From $7\frac{1}{2}$ take $\frac{1}{5}$ of $11\frac{1}{3}$.
3. Find the value of $\frac{5}{8} + \frac{1}{4} + 2\frac{1}{3} + 8\frac{1}{12}$.
4. Reduce to its simplest form, $\dfrac{\frac{1}{2} + \frac{1}{3}}{\frac{1}{2} - \frac{1}{3}} + \dfrac{4\frac{1}{2} \text{ of } \frac{7}{9}}{4\frac{1}{2} + \frac{7}{9}}$.
5. Reduce to its simplest form,

$$\tfrac{1}{2}\left(\tfrac{1}{3} + \tfrac{1}{4}\right) - \tfrac{2}{5}\left(\tfrac{1}{3} - \tfrac{1}{4}\right) + 7\left(8 - 1\tfrac{7}{9}\right)$$

6. Find the value of $\dfrac{7(1\frac{1}{2} \text{ of } \frac{3}{14})}{\frac{1}{6}(\frac{3}{21} \text{ of } 7)} \div \frac{9}{14}$.
7. Find the value of £$\frac{7}{9}$ − £$\frac{3}{4}$ + $\frac{2}{5}$*s.* − $\frac{1}{6}$*s.*
8. Show that $\dfrac{2+3}{5+7}$ is greater than $\frac{2}{5}$ and less than $\frac{3}{7}$.
9. Find the value of $\frac{2}{15}$ of £3 7*s.* 6*d.*, and reduce the result to the fraction of $\frac{1}{2}$ of $2\frac{1}{3}$ of $\frac{1}{4}$ of £12.
10. Simplify $\dfrac{(2\frac{1}{3} - 1\frac{1}{3} + \frac{1}{4})2 - \frac{1}{5}(4\frac{1}{2} - 6\frac{1}{3})}{2 - (\frac{1}{5} + \frac{1}{4} - 2\frac{1}{2})6 - 3\frac{1}{2}}$.

DECIMALS.

Decimals are simply the carrying back notation further than units, each place to the right becoming 10 less, as in whole numbers.

Thus in 11·11 the first 1 stands for 10, the second for 1, the third for $\frac{1}{10}$, the fourth for $\frac{1}{100}$; that is, every figure becomes 10 less for every place to the right.

Therefore to multiply a decimal by 10, 100, &c., we can do so by removing the point as many places to the right as there are 0s.

Thus, 11·11 × 10 = 111·1.

And to divide 10, 100, &c., simply move the point to the left.

Thus, 11·11 ÷ 10 = 1·111.

Cyphers placed to the right of a decimal do not alter its *value, but every cypher placed to the left of a decimal decreases its value tenfold.*

When the same figures recur uniformly, the decimal is called a *recurring* decimal, as in $\frac{1}{37}=\cdot027027027$, &c.

When only *part* of the figures recur the decimal is called a *mixed recurring* decimal, as ·0075555, &c.

When only one figure recurs, it is marked by a point over it, as $\cdot007\dot{5}$ for ·007555, &c.: if several figures recur, by a point over the first and the last, as $\cdot\dot{0}2\dot{7}$ for ·027027, &c., $\cdot5\dot{6}3\dot{7}$ for ·5637637, &c.

To represent a decimal by a fraction.

Place in the numerator the decimal with the point removed, and in the denominator 1 with as many *noughts* as there are decimal places in the given decimal.

Conversely, *a fraction whose denominator is* 10, 100, *&c., may be changed into a decimal by pointing off from the numerator as many decimal places as there are noughts in the denominator.*

Thus, $\frac{25}{100}=\cdot25$; $\frac{25}{1000}=\cdot025$.

EXAMPLES. XXXIX.

Express as fractions: 1. ·25.
2. ·025.
3. ·0025.
4. ·3724.
5. ·6201.

Express as decimals: 6. $\frac{25}{1000}$.
7. $\frac{26}{100}$.
8. $\frac{214}{100000}$.
9. $\frac{3002}{1000}$.
10. $\frac{821}{1000000}$.

ADDITION OF DECIMALS.

Place the numbers under each other, so that the decimal points may be under one another in the same column.

Add up as in whole numbers, and place the decimal point, in the sum, under those in the numbers to be added.

Ex. Add together 3·745, 84·12, and 6·0021.

3·745
84·12
6·0021
93·8671 *Ans.* 93·8671.

If any of the numbers contain circulating decimals, let these be carried out to as many places as there are in the longest of the finite decimals; and if the sum of the recurring figures in the same column as the last finite decimal exceed 5, add 1 to the last decimal figure in the answer.

Ex. Add 3·$\dot{7}\dot{3}$, ·873, 51·$\dot{7}$, 108·2, and 73·463128.

3·737373
·873
51·777777
108·2
73·463128
238·051279 *Ans.* 238·051279.

The answer may be made to recur by carrying the recurring figures back beyond the finite decimal as many places as the least common multiple of the number of recurring figures contained in the quantities. Thus in example there are 3 and 2, therefore 6 places cause the answer to recur.

Ex. Add together, 8·4$\dot{5}$6$\dot{7}$, 6·15241, 84·23$\dot{1}\dot{4}$.

8·45675675675
6·15241
84·23141414141
98·84058089817 *Ans.* 98·84058$\dot{0}$8981$\dot{7}$.

EXAMPLES. XL.

Add together:

1. 8·4213, 82·70012, 21·001.
2. 245·1, 82·10017, 3·2109.
3. ·07021, ·070054, 1·2735, 25·754.
4. 245·127648, 82·1021, 6·4213, 9·821034.
5. 7·123, ·21793, 8·1, 24·0019, 6·10299845.
6. 7·21$\dot{3}\dot{4}$, 8·21964, 7·8$\dot{1}$4$\dot{5}$.
7. 9·17562, 8·1$\dot{7}$28$\dot{4}$, 59·2$\dot{7}$.
8. 16·001, ·0024, 56·1, 10·991$\dot{2}$, 8·76$\dot{4}$5$\dot{4}$.

9. 7·199876, 2456·741$\dot{2}$37, 87·1021, 20793·1$\dot{2}$, 857·21998756.

10. 7·21$\dot{3}$, 8·42$\dot{1}$7$\dot{9}$, 645·$\dot{2}\dot{3}$, 879·4$\dot{5}$6$\dot{2}$, 7·$\dot{4}$21$\dot{3}$.

SUBTRACTION OF DECIMALS.

Place the lesser number under the greater, observing the same rules as in addition.

Ex. From 12·3846 take 3·78454.

$$\begin{array}{r} 12\cdot3846 \\ \underline{3\cdot78454} \\ 8\cdot60006 \end{array}$$

Ans. 8·60006.

If the quantity to be subtracted from contains recurring decimals, let them be carried back, so as to give the recurring figures in the answer.

Ex. From 18·42$\dot{1}$3$\dot{6}$ take 7·214096.

$$\begin{array}{r} 18\cdot421361361 \\ \underline{7\cdot214096} \\ 11\cdot207265361 \end{array}$$

Ans. 11·207265$\dot{3}$6$\dot{1}$.

If the quantity to be subtracted contains circulating decimals, let them be carried back, so as to give the recurring figures in the answer.

Ex. From 16·21489 take 6·21$\dot{4}$.

$$\begin{array}{r} 16\cdot2148900 \\ \underline{6\cdot2141414} \\ 10\cdot0007485 \end{array}$$

Ans. 10·00074$\dot{8}\dot{5}$.

If both quantities recur, the answer may be made to recur by carrying the remaining figures back beyond the finite decimals, as many places as the least common multiple of the recurring figures contained in the quantities. Thus in the example there are 3 and 2, therefore 6 places cause the answer to recur.

From 8·1$\dot{2}$3$\dot{4}$ take 7·213$\dot{4}\dot{5}$.

$$\begin{array}{r} 8\cdot123423423 \\ \underline{7\cdot213454545} \\ \cdot909968877 \end{array}$$

Ans. ·909$\dot{9}$6887$\dot{7}$.

EXAMPLES. XLI.

	From	Take
1.	$8{\cdot}213$	$4{\cdot}612$.
2.	$16{\cdot}217\dot{8}$	$6{\cdot}9917$.
3.	$24{\cdot}123$	$18{\cdot}12374$.
4.	$1{\cdot}2781$	$1{\cdot}00219$.
5.	$29{\cdot}12\dot{1}3\dot{4}$	$8{\cdot}1295$.
6.	$29{\cdot}\dot{1}2\dot{3}$	$84{\cdot}72945$.
7.	$146{\cdot}59\dot{1}$	$76{\cdot}21009$.
8.	$7{\cdot}214937$	$5{\cdot}12\dot{3}$.
9.	$201{\cdot}23645$	$179{\cdot}\dot{0}1\dot{3}$.
10.	$27{\cdot}845\dot{6}\dot{2}$	$7{\cdot}4\dot{2}1\dot{3}$.

PAPER No. 16.

1. What number added to 874 will equal the product of 360 and 450?

2. What number is to 7 as 6 is to 24?

3. Reduce 18 cub. yds. 20 cub. ft. 189 cub. in. to cubic inches.

4. Reduce $\frac{27968}{37376}$ to its lowest terms.

5. Add together $7\frac{1}{2}$, $5\frac{1}{6}$, $\frac{1}{2}$ of $7\frac{1}{5}$.

6. Simplify $\dfrac{7\frac{2}{3}-6\frac{1}{2}\times\frac{1}{4}}{(7\frac{2}{3}-6\frac{1}{2})\frac{1}{4}}$.

7. Reduce 2 cwt. 3 qrs. 7 lbs. to the fraction of 1 ton 5 cwt. 2 qrs.

8. Express $74{\cdot}213$ in words.

9. Express $\frac{8459}{100000}$ as a decimal.

10. Add together $7{\cdot}2134$, $84{\cdot}2\dot{1}3\dot{6}$, $217{\cdot}908$, $21{\cdot}36459\dot{7}$.

MULTIPLICATION OF DECIMALS.

Multiply as in whole numbers.

Mark off in the product as many decimal places as there are in the multiplier and the multiplicand together.

If there be not a sufficient number of decimal places in the product, supply the deficiency by placing noughts to the left of it.

Ex. Multiply 4·735 by ·74.

$$\begin{array}{r} 4{\cdot}735 \\ \underline{{\cdot}74} \\ 18940 \\ \underline{33145} \\ 3{\cdot}50390 \end{array}$$

Ans. 3·5039.

Proof:

$$4{\cdot}735 \times {\cdot}74 = \frac{4735}{1000} \times \frac{74}{100}.$$
$$= \frac{350390}{100000}.$$
$$= 3{\cdot}50390.$$

EXAMPLES. XLII.

Multiply:

1. 7·4 × ·2.
2. 2·01 × ·12.
3. 214·21 × 7.
4. 7·1056 × 8·213.
5. 2·1204 × ·0012.
6. 7·124 × 1·207.
7. ·2015 × 3·012.
8. 7·4213 × 1000.
9. 7·4213 × 100.
10. 7·4213 × 100000.

DIVISION OF DECIMALS.

Add cyphers if necessary to the right of the dividend.

Divide as in whole numbers.

If there are more decimal places in the dividend than in the divisor, mark off in the answer as many places as there are more decimal places in the dividend than in the divisor, as in the following example. There are 2 in the dividend and 1 in my divisor.

∴ Mark off 1 in the answer.

$$\begin{array}{l} {\cdot}1){\cdot}01({\cdot}1 \\ \phantom{{\cdot}1){\cdot}0}\underline{1} \\ \phantom{{\cdot}1){\cdot}0}{\cdot} \end{array}$$

If there are the same number of decimal places in the dividend as in the divisor, the answer will be a whole number, as in the following example. There is 1 in the dividend and 1 in the divisor.

∴ There are none in the answer.

·1)·1(1
1
·

If there are more decimal places in the divisor than in the dividend, there cannot be any decimal places in the answer, but the answer must be made greater, by adding as many noughts to the right as there are more decimal places in the divisor than in the dividend: as in the following example there are 2 in the divisor and 1 in the dividend.

∴ The answer is increased by adding 0 to the right.

·01)·1(10
1
·

Should the decimal not come out, carry the decimal figure in the answer to four places, unless the answer is a recurring decimal, which will be the case if the divisor is divisible by 3, 7, or 11.

19·8)6·87000(·34$\dot{6}\dot{9}$
5 94
930
792
1380
1188
1920
1782
138

Ans. ·34$\dot{6}\dot{9}$.

Examples. XLIII.

Divide

1. ·4 by 2.
2. ·04 by 2.
3. ·4 by ·2.
4. 4 by ·2.
5. ·213 by ·4.
6. ·024 by ·00025.
7. 28·8 by ·024.
8. 58·41542 by 178·5.
9. 5·6 by ·0333.
10. 7·4619 by 1·998.

PAPER No. 17.

1. If a farm of 396 ac. 3 rds. 10 per. be let for £740 14*s.* 4*d.* a year, what is the rent per acre?

2. If 12 horses can plough 48 ac. in 6 days, how long will the same horses take to plough 200 acres?

3. Simplify $\dfrac{2(\frac{1}{2}-\frac{1}{3}+2\frac{1}{2})-3(4\frac{1}{2}-2\frac{1}{3}-\frac{1}{4})}{2-\frac{1}{3}(4\frac{1}{9}\text{ of }\frac{1}{5}+\frac{1}{3}-\frac{1}{6}\text{ of }\frac{2}{3})}$.

4. Find the value of £$2\frac{1}{3}+5\frac{1}{6}$*s.*$-2\frac{1}{4}$*d.*

5. Add together $7821{\cdot}\dot{3}$, $9{\cdot}0\dot{2}1\dot{3}$, $275{\cdot}3\dot{1}\dot{7}$, $21{\cdot}4\dot{5}6$.

6. Multiply ·00124 by 3·21.

7. Divide 24·56 by ·12.

8. Divide 28·8 by ·024.

9. Divide 417·8125 by 37·5.

10. Simplify $\dfrac{24{\cdot}56-21{\cdot}24}{24{\cdot}56+21{\cdot}24}$.

To reduce a vulgar fraction to a decimal.

Add decimal cyphers to the numerator, and divide by the denominator.

Ex. Reduce $\frac{3}{7}$ to a decimal.

$$7\underline{)3{\cdot}000000}$$
$$\cdot428571$$

Ans. $\cdot\dot{4}2857\dot{1}$.

EXAMPLES. XLIV.

Reduce to decimals:

1. $\frac{1}{2}$.
2. $\frac{3}{4}$.
3. $\frac{5}{14}$.
4. $\frac{7}{27}$.
5. $\frac{21}{40}$.
6. $\frac{7}{9}$.
7. $\frac{5}{11}$.
8. $\frac{\cdot56}{333}$.
9. $\frac{241}{846}$.
10. $\frac{\cdot7102}{10025}$.

To find the value of a recurring decimal.

Subtract from the given decimal, with the point removed, the figures which do not recur, and place the difference over as many 9s as there are recurring figures, and as many 0s to the right of the 9s as there are non-recurring figures.

Ex. $\cdot 23\dot{8}4\dot{8}$.

$$\cdot 23\dot{8}4\dot{8} = \frac{23848-23}{99900}$$
$$= \frac{23825}{99900}$$
$$= \frac{953}{3996}$$

EXAMPLES. XLV.

Reduce to equivalent vulgar fractions:

1. $\cdot\dot{3}$.	6. $\cdot 04\dot{1}\dot{6}$.
2. $\cdot 0\dot{3}$.	7. $\cdot 372\dot{4}6\dot{7}$.
3. $\cdot\dot{2}\dot{7}$.	8. $\cdot\dot{0}024\dot{6}$.
4. $\dot{2}6\dot{5}$.	9. $2\cdot 1\dot{0}\dot{6}$.
5. $4\dot{1}\dot{6}$.	10. $3\cdot 1\dot{7}24\dot{9}$.

PAPER No. 18.

1. Express in words 701234213900213.

2. Bought 50 dozen of wine for a hundred guineas: how much is that a bottle?

3. £45 8*s*. is equally divided among 32 persons: by how much does the share of 24 of them exceed that of the rest?

4. Add together $7\frac{1}{2}$, $5\frac{1}{9}$, $6\frac{2}{3}$, $8\frac{7}{15}$.

5. Find the value of $\dfrac{4\frac{1}{2}+\frac{1}{3}}{4\frac{1}{2}-\frac{1}{3}}$ of £25 2*s*. 1*d*.

6. Add together $8\cdot 127021$, $29\cdot\dot{3}1\dot{7}$, $4201\cdot 21$, and $364\cdot 2\dot{1}45\dot{6}$.

7. Divide 681980 by $\cdot 215$.

8. Simplify $\dfrac{2\frac{1}{4}-\frac{1}{5}}{4\cdot 25-3\cdot 275}+\dfrac{2\left(\frac{1}{5}+2\frac{1}{2}\right)}{2\left(2\cdot 1-1\cdot 025\right)}$.

9. Reduce $\frac{725}{1246}$ to a decimal.

10. Reduce $\cdot 8\dot{2}1\dot{6}$ to a fraction.

To reduce a quantity to the decimal of another quantity of a higher name.

Add cyphers to the lowest name, and divide successively by as many of the less as make one of the greater.

Ex. Reduce 18*s.* 9¾*d.* to the decimal of £1.

4)3·0000*q.*
12)9·7500*d.*
20)18·81250*s.*
£ ·940625

∴ 18*s.* 9¾*d.* = £·940625 *Ans.* ·940625.

Conversely, to find the value of a decimal, multiply successively by as many of the less as make one of the greater.

Ex. Find the value of £·940625.

£
·940625
20
18·812500*s.*
12
9·750000*d.*
4
3·000000*q.*

∴ £·940625 = 18*s.* 9¾*d.* *Ans.* 18*s.* 9¾.

EXAMPLES. XLVI.

Reduce :

1. 3*s.* 4*d.* to the decimal of £1.
2. 4*s.* 5d. to the decimal of £1.
3. 8*s.* 6½*d.* to the decimal of £1.
4. 1 cwt. 2 qrs. to the decimal of 1 ton.
5. 3 cwt. 2 qrs. 7lbs. to the decimal of 1 ton.
6. Find the value of £·68464.
7. Find the value of £·5433.
8. Find the value of £·4166.
9. Find the value of ·625 cwt.
10. Find the value of ·603125 ac.

To reduce one quantity to the decimal of another quantity.

Reduce the quantities to the lowest denomination mentioned, and divide the quantity to be reduced by the quantity to the decimal of which it is to be reduced.

EXAMPLES. XLVII.

Reduce:

1. 2*s*. 6*d*. to the decimal £1 4*s*.
2. £1 3*s*. 6*d*. to the decimal of £2 3*s*. 6*d*.
3. ½ (£2 3*s*. 6*d*.) to the decimal of £5 3*s*. 6½*d*.
4. 4 cwt. 2 qrs. to the decimal of 10 cwt. 2 qrs. 7 lbs.
5. 5 hours 48 min. 50 sec. to the decimal of 1 day.
6. ⅑ of £3 6*s*. to the decimal of ¼ of £10 2*s*. 6*d*.
7. 5*s*. to the decimal of 13*s*. 4*d*.
8. £5 3*s*. 6⅓*d*. to the decimal of £9 3*s*. 6¼*d*.
9. £8 2*s*. 7⅕*d*. to the decimal of £16 5*s*. 2⅗*d*.
10. ¾ of 5*s*. 6*d*. to the decimal of £1.

RULE OF THREE IN DECIMALS.

The statement and operation are the same as in whole numbers, but the terms are reduced, multiplied, and divided by the rules of decimals.

EXAMPLES. XLVIII.

1. If ·25 cwt. cost £8 8*s*., how much can be bought for £88?

2. If ·024 of a mine is worth £245, what is the value of ·84 of it?

3. If 1·5 oz. of gold is worth £4 10*s*., what is the value of 3·25 oz.?

4. If 1 cwt. of sugar cost £2·25, what would be the value of 2·5 qrs.?

5. If a train travelling at the rate of 38·24 miles per hour takes 3·25 hours to perform a journey, how long will it take a train going at a speed of 35·6 miles per hour to accomplish the same distance?

6. If 1 cwt. cost £2 16*s*., what will 40½ cwt. come to?

7. If 6·25 tons of iron cost £218 15*s*., what is the value of 1 ton?

8. If 10 lbs. of sugar cost ·08 of £2⅘, what is the value of 3¼ cwt.?

9. If $3\cdot\dot{3}$ lbs. of tea cost 11*s*. 9d., what would be the value of $4\cdot\dot{8}\dot{1}$ cwt.?

10. If a train, which travels at the rate of 35·5 miles an hour, performs a certain journey in $11\frac{3}{4}$ hours, in what time would a train do it travelling 42·75 miles an hour?

PAPER No. 19.

1. Reduce 2 miles 3 fur. 5 poles $4\frac{1}{2}$ yards 6 in. to barleycorns.

2. Find the value of 3 cwt. 16 lbs. 10 ozs. of sugar at £3 16*s*. 4*d*. per cwt.

3. Find the least common multiple of 16650, 10730, and 1961.

4. Find the value of $3\frac{2}{5} \times \frac{7\frac{1}{7} \text{ of } 1\frac{2}{5}}{3\frac{1}{5}}$.

5. Express $2\frac{2}{5}$ of £15 16*s*. 3*d*. as the fraction of £50 4*s*. 9*d*.

6. Multiply 65·54335 by 2·035, and divide the product by ·0135.

7. Reduce $3\cdot124\dot{5}\dot{6}$ to an improper fraction.

8. Express $\frac{1}{2}\frac{1}{7}$ of 10*s*. 6*d*. as the decimal of £5 5*s*.

9. Simplify $\frac{\cdot02(4\cdot5-3\cdot005)}{\frac{7}{8}(2\cdot4\div8\cdot848)}$.

10. If ·2425 of an estate is worth £8500, what is the value of $\cdot141\dot{6}$ of it?

PRACTICE.

Practice is a ready way of finding the value of any quantity, when the price of a unit of it is given.

All the examples that occur are similar to one or other of the five following. The operations will sufficiently explain themselves.

Ex. 1. What is the value of 846 ozs. at ¾*d.* per oz.

			d.	
			846	= Value at 1*d.* per oz.
½*d.*	½	1*d.*	423	= ,, ½*d.* ,,
¼*d.*	½	½*d.*	211½	= ,, ¼*d.* ,,
			12)634½	¾*d.* ,,
			2,0)5,2*s.* 10*d.*	
			£2 12*s.* 10½.	*Ans.* £2 12*s.* 10½.

Ex. 2. Find the value of 2153 lbs. of beef at 9¾*d.* per lb.

			s.	*d.*	
			2153	0	= value at 1*s.* per lb.
6*d.*	½	1*s.*	1076	6	= ,, 6*d.* ,,
3*d.*	½	6*d.*	538	3	= ,, 3*d.* ,,
¾*d.*	¼	3*d.*	134	6¾	= ,, ¾*d.* ,,
			2,0)174,9	3¾	9¾*d.* ,,
			£87 9*s.*	3¾	*Ans.* £87 9*s.* 3¾*d.*

Ex. 3. Find the value of 3271 cwt. at 5*s.* 9½*d.* per cwt.

			£	*s.*	*d.*	
			3271	0	0	= value at £1 each.
5*s.*	¼	£1	817	15	0	= ,, 5*s.* ,,
6*d.*	⅒	5*s.*	81	15	6	= ,, 6*d.* ,,
3*d.*	½	6*d.*	40	17	9	= ,, 3*d.* ,,
½*d.*	⅙	3*d.*	6	16	3½	= ,, ½*d.* ,,
			£947	4	6½	5s. 9½

Ans. £947 4*s.* 6½*d.*

Ex. 4. Find the value of 2710 articles at £2 3*s.* 1½*d.* each.

			£	*s.*	*d.*	£ *s.* *d.*
			2710	0	0	= value at 1 0 0 each.
					2	
			5420	0	0	= ,, 2 0 0 ,,
2/6	⅛	£1	338	15	0	= ,, 2 6 ,,
6	⅕	2/6	67	15	0	= ,, 6 ,,
1½	¼	6*d.*	16	18	9	= ,, 1½ ,,
			£5843	8	9	2 3 1½ each.

Ans. £5843 8s. 9*d.*

Ex. 5. Find the value of 25 cwt. 2 qrs. 14 lbs. at £3 17*s.* 6*d.* per cwt.

			£	*s.*	*d.*	
			3	17	6	= value of 1 cwt.
					5	
			19	7	6	= ,, 5 cwt.
					5	
			96	17	6	= ,, 25 cwt.
2 qrs.	½	1 cwt.	1	18	9	= ,, 2 qrs.
14 lbs.	¼	2 qrs.		9	8¼	= ,, 14 lbs.
			£99	5	11¼	25 cwt. 2 qrs. 14 lbs.

Ans. £99 5*s.* 11¼*d.*

EXAMPLES.

1. Find the value of 7213 lbs. of tea at 2*s.* 11*d.* per pound.

2. Find the value of 10564 cwt. of sugar at £2 3*s.* 6*d.* per cwt.

3. How much must be given for 1007 articles, at 1*s.* 10¾*d.* apiece?

4. Find the value of 10 dozen bottles of wine at 2*s.* 10½*d.* per bottle.

5. What will 9648 times £2 12*s.* 6*d.* amount to?

6. Find the value of 6 cwt. 1 qr. 7 lbs. at £1 8*s.* 6*d.* per cwt.

7. Find the value of 81 cwt. 2 qrs. 14 lbs. at £2 3*s.* 6*d.* per cwt.

8. Find the value of 3 cwt. 2 qrs. 8 lbs. of coal at £2 2*s.* 6*d.* per ton.

9. Find the value of 23 ac. 1 rd. 10 pls. at £42 10*s.* 6*d.* per ac.

10. If 1 ton of hay cost £3 10*s.* 6*d.*, what is the value of 7 tons 14 cwt. 2 qrs. 25 lbs.?

PAPER No. 20.

1. Express in words 100021000174, and 82·3175.

2. Multiply £18 14*s.* 8¼*d.* by 22¾.

3. If £72 10*s.* 7½*d.* can purchase 5 pieces of cloth, each 33 yards, how many pieces of the same length will 50 guineas and a crown purchase?

4. How many dollars each 3*s.* 7¾*d.* are worth 568 guineas?

5. Find the least common multiple of 7, 14, 27, 36, 48, 50, and 54.

6. Simplify $\dfrac{7(1\frac{1}{2} \text{ of } \frac{3}{14})}{\frac{1}{6}\,(\frac{3}{3\frac{1}{3}} \text{ of } 7)} \div \frac{9}{14}$.

7. Express as a fraction of £5, the difference between £7⅕ and £7 × ⅘.

8. Divide 7·206 by 1·002.

9. Find by Practice the value of 7245 articles at 2*s.* 7½*d.* each.

10. Find the value of 8 cwt. 2 qrs. 11 lbs. at £2 3*s.* 6*d.* per cwt.

CAUSE AND EFFECT.

Assuming that *Cause* and *Effect* are proportionate to one another, we shall have first cause : second cause :: first effect : second effect, and any three of these terms being given, the fourth may be found.

Effect being a result produced by the agency of man, life, time, or anything that cannot be performed by man is always the cause. Money can never be a cause, but is always an effect, except in the case of an interest sum, when the principal, rate per cent., and time are the causes, and the amount paid as interest the effect.

Ex. If 14 men, working 9 hrs. a day, dig a trench 140 yds. long, 2 wide, and 2 deep, in 4 days, in how many days will 36 men at the same rate for 8 hrs. a day dig a trench 280 yds. long, 4 wide, and 2 deep?

$$\begin{array}{c}\text{men dys. hrs.}\\ \left.\begin{array}{r}14 \times 4 \times 9\\ 36 \times x \times 8\end{array}\right\} = \text{First and Second Causes.}\end{array}$$

$$\begin{array}{c}\text{yds. yds. yds.}\\ \left.\begin{array}{r}140 \times 2 \times 2\\ 280 \times 4 \times 2\end{array}\right\} = \text{First and Second Effects.}\end{array}$$

$$\therefore (14 \times 14 \times 9) : (36 \times x \times 8) :: (140 \times 2 \times 2) : (280 \times 4 \times 2).$$

$$\begin{aligned}\therefore x &= \frac{14 \times 4 \times 9 \times 280 \times 4 \times 2}{36 \times 8 \times 140 \times 2 \times 2} \text{ days.}\\ &= \frac{1 \times 1 \times 1 \times 280 \times 1 \times 1}{4 \times 1 \times 10 \times 1 \times 1} \text{ days.}\\ &= \frac{7}{1 \times 1} \text{ days.}\\ &= 7 \text{ days.}\end{aligned}$$

Ans. 7 days.

EXAMPLES. XLIX.

1. If 10 horses in 8 days can plough 40 acres, how many days will it take 8 horses to plough 60 acres?

2. If 8 persons live 16 weeks for £42, how long will £100 support six persons at the same rate?

3. If the carriage of 59 cwt. for 65 mls. cost £2 5*s.*, how many cwt. may be carried 40 mls. for £3 15*s.*?

4. If 30 bushels of corn serve 3 horses for 50 days, how many days will 150 bushels serve 30 horses at the same rate?

5. If £15 12*s.* pay 16 labourers for 18 days, how many labourers will £35 2*s.* pay for 24 days?

6. If a railway cutting, 1700 yds. long, 10 yds. wide, 16 ft. deep, can be made by 300 men in 60 days, when working 8 hrs. a day, how long would it take 500 men to cut an opening of 12 yds wide through a hill 1800 yds. long, the average height being 25 ft., supposing the men worked 9 hrs. a day?

7. If a pond 100 ft. long, 40 ft. broad, and 4 ft. deep, can be filled by a steam pump in 4 days when pumping 6 hrs. a day, what time would it take to fill another pond, 800 ft. long, by 30 ft. broad, by 6 ft. deep, supposing the pump was only half as powerful as the former, but worked 8 hrs. a day?

8. If a regiment of 1050 soldiers consume 702 qrs. of wheat in 835 days, how many qrs. will be required for an army of 20000 men for 55 days?

9. If a garrison of 785 men require 325 tons of flour for 100 days, how long would the garrison be able to hold out, provided their number was increased by 200 men, and the stores by sixty tons, and the allowance per man reduced by $\frac{1}{3}$?

10. If the interest on £5000 at $3\frac{1}{2}$ per cent. produces £350 as interest in two years, at what rate is £524 the interest on £6550 for 4 years?

INTEREST.

Interest is the sum paid for money lent. The money lent is called the *Principal*; the money agreed to be paid for £100 lent for one year is the *Rate per cent.*; the Principal and Interest together, the *Amount.*

SIMPLE INTEREST.

Simple Interest is when interest is paid only on the money lent.

To find the simple interest of a given sum for a given time at a given rate.

Multiply the principal by the rate per cent. and number of years, and divide by 100.

Ex. Find simple interest and amount of £760 10*s.* 6*d.* for $7\frac{1}{2}$ years at 4 per cent.

$$\left.\begin{array}{l}\text{Fraction of principal received}\\ \text{back as interest.}\end{array}\right\} = \frac{\text{rate per cent.} \times \text{no. of yrs.}}{100}$$

$$= \frac{4\times 7\frac{1}{2}}{100}.$$

$$= \frac{4\times 15}{100\times 2}.$$

$$= \frac{3}{10}.$$

	£	*s.*	*d.*	
	760	10	6	
			3	
10)	2281	11	6	
	228	3	$1\frac{4}{5}$	interest
	760	10	6	principal
	£988	13	$7\frac{4}{5}$	amount

Ans. $\begin{cases}\text{Interest, £228 } 3s.\ 1\frac{4}{5}d.\\ \text{Amount, £988 } 13s.\ 7\frac{4}{5}d.\end{cases}$

EXAMPLES. L.

1. Find the simple interest on £820 3*s*. 6*d*. for 4 yrs. at 5 per cent.

2. Find the simple interest and amount of £3842 15*s*. for 3 yrs. at 5 per cent.

3. Find the interest on £721 10*s*. for 3 years at 3 per cent.

4. Find the simple interest and amount of £7124 9*s*. 6*d*. for $2\frac{1}{2}$ yrs. at 3 per cent.

5. What will £302 3*s*. 6*d*. amount to in 10 yrs. at $3\frac{1}{3}$ per cent.?

6. Find the simple interest and amount of £259 13*s*. 5*d*. for 20 wks. at 5 per cent.

7. What interest should be paid for the loan of £2500 for 75 days at $5\frac{1}{2}$ per cent.?

8. Find the amount of £345 2*s*. 6*d*. for 4 yrs. 3 months at $7\frac{1}{2}$ per cent.

9. Find the interest on £6000 at 5 per cent. from March 1st to the 2nd of June.

10. In what time would £2000 amount to £2150 at 3 per cent.?

PAPER No. 21.

1. From $1{\cdot}846\dot{2}\dot{3}$ take $\cdot00196$, and find the difference between $3{\cdot}1\dot{2}4\dot{5}$ and $2\frac{16}{999}$.

2. Find the value of £$\frac{7}{8}$ and $\frac{7}{9}$ of a guinea, and reduce the amount to the decimal of 10*s*.

3. Find by Practice the value of 4002 boxes of oranges at £2 3*s*. 6*d*. per box.

4. If 1 cwt. of coffee is worth £4 13*s*. 4*d*., find by Practice the value of 8 cwt. 1 qr. 16 lbs.

5. If 9 horses consume 18 bushels of oats in one week, how long would 80 bushels last 20 horses?

6. A besieged place garrisoned by 10000 men was victualled for 27 days: after 9 days 2500 men cut their way out: how long would the provisions last the remainder?

7. Find the amount of £375 3*s*. 9*d*. for 8 yrs. at 3½ per cent. simple interest.

8. At what rate simple interest will £250 become £300 12*s*. 6*d*. in 4½ years?

9. What would be the interest on £3560 from the 20th of June to the end of the year at 4 per cent.?

10. In how many years will £1 become 30*s*. at 2½ per cent. simple interest?

COMPOUND INTEREST.

Compound Interest is when interest is calculated on the principal and interest.

Ex. Find the compound interest and amount of £250 10*s*. for 4 yrs. at 4 per cent.

£250 10*s*. = £250·5
4 per cent. = $\frac{4}{100}$ of principal ∴ amount is $\frac{104}{100}$

£
250·5 principal
104
10020
2505
260·520 amount for 1 yr.
104
104208
26052
270·94,08 amount for 2 yrs.
104
108376
27094
281·77,76 amount for 3 yrs.
104
112711
28177
293·0411 amount for 4 yrs.

Ans. { Amount, 293·04 or £293 0*s*. 9¾*d*.
Interest, £42 10*s*. 9¾*d*.

EXAMPLES. LI.

Find the compound interest of—

1. £500 at 4 per cent. for 3 yrs.
2. £540 at 4 per cent. for 2 yrs.
3. £150 at $2\frac{1}{2}$ per cent. for 4 yrs.
4. £259 10*s*. for 3 yrs., 9 mths., 10 dys. at $4\frac{1}{2}$ per cent.

Find the amount of—

5. £350 in 3 yrs. at 5 per cent.
6. £400 in $3\frac{1}{2}$ yrs. at 6 per cent.
7. £650 in 5 yrs. at 5 per cent.
8. £550 10*s*. for 3 yrs. 6 mths. at 6 per cent.
9. £300 for $2\frac{1}{2}$ yrs. at $3\frac{1}{2}$ per cent.
10. £413 17*s*. 9*d*. for $2\frac{1}{2}$ yrs. at $4\frac{1}{2}$ per cent.

DISCOUNT.

DISCOUNT is the allowance made for money paid before it is due, and the discount subtracted from the amount gives the *present worth*.

RULE. To find the discount use the proportion, as the amount of £100 for the given time : the given sum :: the interest £100 : discount required.

Ex. What is the discount on £75 due 15 mths. hence at 5 per cent. per annum.

The amount of £100 for 15 mths. (as found by rule p. 70) is £106 5*s*.

$$\begin{array}{rcrcrcl} \pounds\ s. & & \pounds & & \pounds\ s. & & s. \\ 106\cdot 5 & : & 75 & :: & 6\cdot 5 & : & x \\ 20 & & & & 20 & & \\ \hline 2125 & & & & 125 & & \end{array}$$

$$\therefore x = \frac{125 \times 75}{2125} = \frac{75}{17} = \pounds 4\ 8s.\ 2\tfrac{3}{4} - \tfrac{5}{17}q.$$

the discount required.

Hence we may find the *Present Worth.*

$$\begin{array}{rrrl} \pounds & s. & d. & \\ 75 & 0 & 0 & = \text{money due 15 mths. hence} \\ 4 & 8 & 2\tfrac{3}{4} & = \text{discount} \\ \hline 70 & 11 & 9\tfrac{1}{4} & = \text{present worth.} \end{array}$$

The present worth and discount may be found as follows:—

The present worth (P) of any sum (M) due n years hence, is such a sum as, if put to interest for n years, would produce M:

$$\therefore P = \frac{M}{1+nr}$$

The discount (D) = sum due at the end of n years − P

$$\therefore D = M - \frac{M}{1+nr} = \frac{Mnr}{1+nr}.$$

EXAMPLES. LII.

1. What is the discount and present worth of £487 12*s.* 6*d.* for 6 months, at 6 per cent.?

2. What is the present worth of £500, due in 10 months, at 5 per cent.?

3. What is the present worth of £157 10*s.* due 1 year hence, at 5 per cent.?

4. What is the discount of £355 5*s.* due 4 months hence, at 4½ per cent.?

5. Find the discount and present worth of £3005 10*s.* due 3 yrs. hence at 5 per cent.

6. Find the discount and present worth of £812 18*s.* 9*d.* due 10 months hence at 6 per cent.

7. What ought I to pay for an estate worth £40,000, provided I pay the money 3 months in advance, discount at 5 per cent. per annum?

8. Upon what sum at 5 per cent. for 2 yrs. is £250 the discount?

9. What is the difference between the discount and the simple interest on £20,000 at 4 per cent. for 5 years?

10. Bought goods for £150, ready money, and sold them for £200 payable ¾ of a year hence, what was the gain in ready money, discount being at 4½ per cent.?

COMMISSION, BROKERAGE, INSURANCE.

Commission is the sum paid to a merchant for buying or selling goods for another.

Brokerage is a smaller allowance paid usually for transacting money concerns.

Insurance is a payment of so much per cent. to secure property from losses, which may occur by fire, or otherwise.

Rule. As the charge is in each case so much per cent. the rule will be the same as that for finding the simple interest for one year, viz., multiply the sum by the rate per cent. and divide by 100.

Ex. What is the commission on £754 16*s*. at $2\frac{1}{4}$ per cent.?

$$\left.\begin{array}{r}\text{Fraction of principal}\\ \text{received back as commission}\end{array}\right\} = \frac{N \times R}{100} = \frac{2\frac{1}{4}}{100} = \frac{9}{400}$$

```
      £   s.
    754  16
          9
 4)6793   4
  16,98   6
     20
  19·66
     12
   7·92
      4
   3·68
```

Ans. £16 19*s*. $7\frac{3}{4}$–68*q*.

Examples. LIII.

1. Find the commission on £27450 at $2\frac{1}{2}$ per cent.

2. Find the brokerage on £978 10*s*. at 2 per cent.

3. What is the premium on a policy of £3740 at 3 per cent.?

4. What is the charge for insuring a vessel and cargo, worth £3649 8*s*. at $3\frac{1}{2}$ per cent.?

5. I gave £20,000 as purchase money for an estate, 1 per cent. as agent's commission, $\frac{1}{3}$ per cent. for law expenses, and $\frac{1}{2}$ per cent. for stamps. What was the total cost?

6. Find the brokerage on £946 18*s*. 6*d*. at 5*s*. 6*d*. per cent.

7. Add to £579 16*s.* 10*d.* the commission on itself at 7½ per cent.; and find the insurance on the same at 4⅜ per cent.

8. Tobacco is worth 4*s.* per lb.; what would be the duty on 10 cwt. 3 qrs. at 25 per cent.?

9. Upon what sum is £225 11*s.* 3*d.* the commission?

10. At 5½ guineas per cent., how much must be insured on goods worth £813 11*s.* 3*d.*, so that in the case of loss the owner may receive the value of the goods and the premium?

STOCKS.

When a government borrows money, it gives the lenders *bonds*, implying that the nation is indebted to them the sum borrowed, and on that sum interest is paid at the time fixed upon. These bonds are transferable from one person to another.

Each bond is called £100 stock, bearing interest at a certain rate per cent. Thus, in what is called the 3, 3½ or 4 per cents., one of these bonds entitles its owners to £3, £3 10*s.*, or £4 yearly interest.

The value of these bonds fluctuates according to the credit of the country; thus, a bond for £100 stock at 3 per cent. may be worth £95 sterling, or £85 10*s.* or £83 17*s.* 6*d.*, or any other sum.

All transactions in the stocks depend upon the Rule of Proportion, as will appear from Examples.

Ex. How much money will purchase £2,400 in the 3 per cents. at 89½, allowing ⅛ per cent. brokerage?

89½ cost + ⅛ per cent. brokerage = 89⅝

If £89⅝ is the cost of £100 stock, what is the cost of £2400 stock?

$$\begin{array}{ccccc} £ & & £ & & £ \\ \underline{100} & : & \underline{2400} & :: & 89\frac{5}{8} \\ 1 & & 24 & & \underline{8} \\ & & & & 717 \\ & & & & \underline{3} \\ \end{array}$$

£2151 cost of £2400 stock.

Ans. 2151.

Ex. 2. What income would arise from £2500 invested in the 4 per cents. at $95\frac{1}{2}$, allowing for brokerage?

$$95\tfrac{1}{2} + \tfrac{1}{8} \text{ brokerage} = 95\tfrac{5}{8}$$

If $95\frac{5}{8}$ produce £4, what will £2500 produce?

$$\begin{array}{ccccc} £ & & £ & & £ \\ 95\frac{5}{8} & : & 2500 & :: & 4 \end{array}$$

$$£\frac{2500\times4}{95\frac{5}{8}}$$

$$£\frac{2500\times4\times8}{765}$$

$$£\frac{500\times4\times8}{153}$$

$$£\frac{16000}{153}$$

153)16000(£104
153
700
612
88
20
153)1760(11*s.*
153
230
153
77
12
153)924(6*d.*
918

$\frac{6}{153} = \frac{2}{51}$ *Ans.* £104 11*s.* $6\frac{2}{51}$*d.*

What is the difference made in a person's income by selling out £24000 stock in the 3 per cents. at $96\frac{1}{8}$ and investing in the 5 per cents. at $104\frac{7}{8}$, allowing for brokerage?

$\frac{3}{100}$ fraction of principal received as interest in 1st case.
$96\frac{1}{8} - \frac{1}{8}$ or 96 amount received for £100 stock.
$\frac{96}{100}$ or $\frac{24}{25}$ fraction of principal to be invested.
$104\frac{7}{8} + \frac{1}{8}$ or 105 cost of £100 stock in 2nd case.
$\frac{5}{105} \times \frac{24}{25}$ or $\frac{24}{525}$ fraction of 1st stock received in second case as interest,

$$\frac{24}{525} - \frac{3}{100}$$

$$\frac{96}{2100} - \frac{63}{2100}$$

$$\frac{33}{2100} \text{ or } \frac{11}{700}$$

$$\therefore \frac{24000\times11}{700} = \text{difference of income}$$

$$£\frac{240\times11}{7}$$

$\frac{2640}{7} = £377\ 2s.\ 10\frac{2}{7}d.$ *Ans.* £377 2*s.* $10\frac{2}{7}$*d.*

EXAMPLES. LIV.

1. What sum will purchase £254 17*s.* stock at $97\frac{1}{4}$ per cent.?

2. At $104\frac{3}{8}$ per cent., what is the purchase of £1797 14*s.* stock in the 4 per cents.?

3. At $125\frac{5}{8}$ per cent., what is the purchase of £758 17*s.* 10*d.* India stock?

4. What sum will purchase £4000 stock at $63\frac{5}{8}$, brokerage being $\frac{1}{8}$ per cent.?

5. A has £1000 in the 3 per cents. at 84, and B £1000 in the 4 per cents. at 110; find their respective incomes.

6. How much stock at $90\frac{3}{8}$ will £2353 purchase, brokerage being $\frac{1}{8}$ per cent.?

7. What rate of interest arises from money in the 4 per cents., at 95?

8. How much money must be laid out in the 3 per cents., at $69\frac{7}{8}$, to produce £100 a year?

9. What sum, including $\frac{1}{8}$ per cent. for brokerage, must be invested in the 3 per cents., at $90\frac{7}{8}$, to produce an income of £500 a year?

10. What difference would be made in a person's income by selling out £28400 stock in the 3 per cents. at 95, and investing in the 6 per cents. at $119\frac{7}{8}$?

BARTER, PROFIT AND LOSS.

THE method of working these rules will be readily suggested by the examples.

N.B. All cases of gain must be calculated on the cost price.

Ex. 1. How much tea at 9*s.* per lb. must I receive for 4 cwt. 2 qrs. of chocolate at 4*s.* per lb.?

$$\begin{array}{rcrcrr}
s. & & s. & & \text{cwt.} & \text{qrs.} \\
9 & : & 4 & :: & 4 & 2 \\
 & & & & & 4 \\
\hline
 & & & 9) & 18 & 0 \\
\hline
 & & & & 2 & 0 \text{ quantity at } 9s. \text{ per lb.}
\end{array}$$

Ans. 2 cwt.

2. How much will be gained by selling 4 cwt. 3 qrs. of sugar at 4*d.* per lb., of which the cost price was £7 2*s.* 6*d.*?

cwt. qrs.
4 3
4
19 qrs.
28
152
38
3)532 lbs.
2,0)17,7*s.* 4*d.*
£8 17 4 selling price
£7 2 6 cost price
£1 14 10 gain *Ans.* £1 14*s.* 10*d.*

Ex. 3. Find the gain per cent. by selling barley at 38*s.* per quarter, the cost price of which was 36*s.*

s.
38 selling price
36 cost price
2 gain

If 36*s.* gain 2*s.*, what will £100 gain?

s. : £ :: *s.*
36 : 100 :: 2
18 9)50 1
9 £5 11*s.* $1\frac{1}{3}$*d.* gain per cent.

Ans. £5 11*s.* $1\frac{1}{3}$*d.* gain per cent.

Ex. 4. What is the cost price of barley per quarter, when by selling at 38*s.* £5 11*s.* $1\frac{1}{3}$*d.* per cent. is gained?

£ *s.* *d.*
100 0 0 cost price
5 11 $1\frac{1}{3}$ gain
105 11 $1\frac{1}{3}$ selling price

If £100 is the cost price of £105 11*s.* $1\frac{1}{3}$*d.*, what is the cost price of 38*s.*?

£ *s.* *d.* : *s.* :: £
105 11 $1\frac{1}{3}$: 38 :: 100
20 1 20
2111*s.* 2000*s.*
12 12
25333*d.* 24000*d.*
3 3
76000 one third pence 72000 one third pence
76 72
2 36*s.*
1 *Ans.* 36*s.*

Ex. 5. If £5 11*s.* 1⅓*d.* per cent. is lost by selling barley at 34*s.* per quarter, what would be the gain or loss per cent. by selling it at 38*s.* per quarter?

£	*s.*	*d.*	
100	0	0	cost price
5	11	1⅓	loss
94	8	10⅔	selling price

If by selling at the rate of 34*s.* £100 produce £94 8*s.* 10⅔*d.*, what will £100 produce by selling at the rate of 38*s.* per quarter?

s. : *s.* :: £ *s.* *d.*
34 : 38 :: 94 8 10⅔
17 19 6
566 13 4
3
1700 0 0
94 8 10⅔
17)1794 8 10⅔(£105
17
94
85
9
20
17)188(11*s.*
17
18
17
1
12
17)22(1*d.*
17
5
3
17)17(⅓
17

£	*s.*	*d.*	
105	11	1⅓	selling price
100	0	0	cost price
5	11	1⅓	gain per cent.

Ans. £5 11*s.* 1⅓*d.*

If by selling barley at 38*s.* per quarter I gained £5 11*s.* 1⅓*d.* per cent., what should I have sold it at to have had a loss of £5 11*s.* 1⅓*d.* per cent.?

£	s.	d.	
100	0	0	cost price
5	11	$1\frac{1}{3}$	gain
105	11	$1\frac{1}{3}$	selling price in 1st case
100	0	0	cost price
5	11	$1\frac{1}{3}$	loss
94	8	$10\frac{2}{3}$	selling price in 2nd case

If by selling at £105 11*s*. $1\frac{1}{3}$*d*. it realises 38*s*. per quarter, what will it realise by selling at £94 8*s*. $10\frac{2}{3}$*d*.?

£	s.	d.		£	s.	d.		s.
105	11	$1\frac{1}{3}$	:	94	8	$10\frac{2}{3}$	::	38
20				20				1
2111*s*.				1888*s*.				
12				12				
25333*d*.				22666*d*.				
3				3				
76000				68000				
76				68				
2				34*s*. selling price per quarter.				
1								

Ans. 34*s*.

EXAMPLES. LV.

1. How much tea at 1*s*. $7\frac{3}{4}$*d*. per lb. must be given for 2 cwt. 13 lbs. of sugar at 9*d*. per lb.?

2. A has raisins at $7\frac{1}{2}$*d*. per lb., and B cheese at 5*d*. per lb.; what quantity of raisins should be given for 3 cwt. 3 qrs. 7 lbs. of cheese?

3. If 1 cwt. of rice be bought for £2 8*s*., and sold for $6\frac{1}{2}$*d*. per lb., what is the gain?

4. If tea be bought at 6*s*. 6*d*. per lb., and sold at 4*s*. 4*d*., what is the loss per cent.?

5. If lead which cost £2 2*s*. 6*d*. per cwt. be sold at a loss of 7 per cent., at what rate per cwt. is it sold?

6. How must butter, which cost £5 14*s*. 10*d*. per cwt., be sold to gain 19 per cent.?

7. If 15 per cent. be gained by selling sugar at £2 10*s*.

per cwt., how much is gained per cwt. by selling at £2 5*s.* 6*d.* per cwt.?

8. If by selling a horse for £42 I gained 5 per cent., what ought I to have sold it for to have cleared 25 per cent.?

9. By selling a house for £3000 I gained 10 per cent.; what per cent. should I have lost if the house had only realised £2500?

10. What must I charge for cloth, for which I gave 19*s.* a yard, that I may have 25 per cent. profit, after allowing 5 per cent. discount?

PAPER No. 22.

1. Simplify $20(\frac{1}{4}+2\frac{1}{2})\cdot 5 - 7(\frac{14}{15}+\frac{21}{25})\cdot 75$.

2. Find the value of 8·312 cwt. + 1·23 qrs. + 1·616 lbs. of sugar at 4*d.* per lb.

3. If 10 men can reap a field of 12 acres in 2 days of 10 hrs. each, in how many days of 9 hrs. each will 15 men reap 36 acres?

4. Find the discount on £3420 for 9 mths. at 4 per cent.

5. Find the commission on £34872 10*s.* at $\frac{1}{4}$ per cent.

6. What annual income would arise from £3924 10*s.* stock, in the 3 per cents.?

7. What difference would be made in a person's income by selling out £10,000 stock in the 3 per cents. at 95, and investing in the Great Northern 6 per cents. at £130$\frac{7}{8}$, allowing for brokerage?

8. How much would be gained by selling 7 tons 3 cwt. of salt for £5, the cost price of which was $\frac{1}{4}$*d.* for 4 lbs.?

9. How much per cwt. would be gained by selling tea at 2*s.* 6*d.* per lb., which cost 2*s.* 1*d.*?

10. If by selling an estate for £34,560 I gained a clear 10 per cent., what was the purchase money, the cost of conveyance, purchase, and sale being £850?

FELLOWSHIP, AND DIVISION INTO PROPORTIONAL PARTS.

Fellowship is the rule by which two or more persons having a joint stock, determine their shares in the profit or loss.

Division into proportional parts shows how to divide a given quantity into parts, which shall have given ratios to each other.

Rule. Add together all the stocks, and as the whole stock is to each man's share of it, so is the whole profit or loss to each man's share of it.

Rule. As the sum of the numbers expressing the ratios is to any of those numbers, so is the quantity to be divided to the part corresponding to the number, in the second place of the proportion.

Ex. 1. Two persons, A and B, trade together: A puts in £6000 and B £4000. They gain £1500. What is each person's share?

$$\begin{array}{rr} & \pounds \\ \text{A's share} & 6000 \\ \text{B's share} & \underline{4000} \\ \text{(A + B)'s share} & 10000 \end{array}$$

If £10,000 gain £1500, what will £6000 gain?

$$\begin{array}{ccccc} \pounds & & \pounds & & \pounds \\ \underline{10000} & : & \underline{6000} & :: & \underline{1500} \\ \underline{10} & & \underline{6} & & 300 \\ \underline{2} & & 3 & & \underline{3} \\ 1 & & & & \pounds 900 \text{ A's share} \end{array}$$

$\therefore$ £1500 − £900 = £600 or B's share

$$\textit{Ans.}\begin{cases}\text{A's } \pounds 900.\\ \text{B's } \pounds 600.\end{cases}$$

When each man's portion of the profit or loss depends upon the principal and time jointly, multiply the two together and proceed as before.

Ex. 2. A and B enter business. A puts in £6000 and remains in the business 5 years. B puts in £4000 and keeps on the business 2 years after A leaves: as all the profit amounted to £3,000, what was the share of each?

$$\begin{aligned} \text{A's share} &= 6000 \times 5 = 30000 \\ \text{B's share} &= 4000 \times 7 = \underline{28000} \\ \text{(A + B)'s share} &= 58000 \end{aligned}$$

If £58,000 gain £3000, what will £30,000 gain?

$$\begin{array}{ccccc} \pounds & & \pounds & & \pounds \\ \underline{58000} & : & \underline{30000} & :: & 3000 \\ \underline{58} & & \underline{30} & & \underline{\quad 15} \\ 29 & & 15 & & 29)45000(\pounds 1551 \end{array}$$

29)45000(£1551
29
160
145
150
145
50
29
21
20
29)420(14s.
29
130
116
14
12
29)168(5d.
145
23
4
29)92(3q.
87
5

A's share £1551 14s. $5\frac{3}{4}$d.

∴ B's share £3000 − £1551 14s. $5\frac{3}{4}$d. or £1448 5s. $6\frac{1}{4}$d.

Ans. $\begin{cases} \pounds 1551 \;\; 14s. \;\; 5\frac{3}{4}d. \\ \pounds 1448 \;\; 5s. \;\; 6\frac{1}{4}d. \end{cases}$

Ex. 3. Divide 350 into three parts that shall be to one another as 5, 12 and 18.

1st 5
2nd 12
3rd 18
sum 35

If 35 is 350 what is 5?

$$\frac{35}{1} : 5 :: \frac{350}{10}$$

$$\begin{array}{r} 10 \\ \underline{5} \\ 50 \end{array}$$

If 35 is 350 what is 12?

$$\frac{35}{1} : 12 :: \frac{350}{10}$$

$$\begin{array}{r} 10 \\ \underline{12} \\ 120 \end{array}$$

∴ 3rd part is $350-(50+120)$ or $350-170$, or 180

$$\textit{Ans.}\begin{cases} 50 \\ 120 \\ 180 \end{cases}$$

EXAMPLES. LVI.

1. Two persons embark in trade; one puts into the business £5550, and the other £3420, and they gain £1260; what is each man's gain?

2. A, B, C trade together; A puts in £100, B £150, C £200, and they gain £900; what is each man's gain?

3. A, B, C are in partnership: A puts in £3640, B £4820, and C £5000, they gain £8670; what is each man's share?

4. Divide a common of 165 acres among A, B, C, according to their rents, which are severally £900, £1050, and £800.

5. A, B, C, and D buy a ship: A takes 6 shares, B 7, C 3, and D 2: they receive for a voyage £315 14*s.* 6*d.*; how much of this ought each to receive?

6. A, B, C rent a meadow for £80: A puts in 8 cattle for 180 days, B 6 cattle for 150 days, and C 20 cattle for 123 days; how much of the rent should each pay?

7. A has stock of £280 in business for 5 months, B has £266 13*s.* 4*d.* for 6 months: the whole gain is £331 12*s.* 6*d.*; what is each man's share?

8. Divide 38400 into three parts, which shall be to one another as 100, 150, and 134.

9. Bell metal contains 3 parts of copper and 1 of tin;

how much tin and copper are there in a bell weighing 150 lbs.?

10. A straight line is 12 ft. 3 in. long; divide it into two parts, which shall be to each other as 3 and 4.

PAPER No. 23.

1. Express in words 12900001374000.

2. Reduce 241567840 half inches to miles.

3. Simplify $\frac{7+3\frac{1}{2}(\frac{1}{2}+4\frac{1}{9})-6\frac{1}{7}}{\cdot 03(\frac{1}{5}+\frac{1}{4})-3(\cdot 21+\cdot 3\dot{4})}$.

4. Find the value of £·345 + 8·2*s.* − 2·1*d.*

5. If 3 hogsheads of brandy, at 6*s.* 8*d.* per gall., be given for 126 yds. of cloth, what was the cloth per yard?

6. Find the simple interest and amount of £52134 for 4 years at 5 per cent.

7. If the cost of an army of 50,000 men is £1,000,000 for 8 weeks, how much would 10,000 men cost for 9 weeks?

8. What would be the difference in a person's income, if, instead of investing £40,000 in the 3 per cents. at 95$\frac{7}{8}$, he had invested in the 4 per cents. at 100, allowing for brokerage?

9. If a tradesman gain 3*s.* 4$\frac{1}{2}$*d.* on an article which cost him £1 13*s.* 9*d.*, how much does he gain per cent.?

10. There are five partners in a business which produces £2100 profit; the senior partner has 6 shares, the second 4, the third 2, and the two junior partners 1 share each; what does each receive?

EXCHANGE.

EXCHANGE is the act of paying or receiving the money of one place for its equivalent in the money of another.

A bill of exchange is a written order for the payment of a certain sum of money at an appointed time.

The *rate, or course of exchange,* is the *uncertain* sum of money of one place, which is given for a *certain* sum of that of another place. Thus, London gives to Paris the *certain* for the *uncertain*, *i.e.*, the £ sterling for an uncertain number of francs, varying according to the circumstances of trade.

The *par of exchange* is such a quantity of the money of one place as is equal to a certain quantity of the money of another.

Agio, in Amsterdam and other places, is the difference between their current money, called the *currency*, and the money of exchange, or that issued from the bank called *banco*, the latter being usually finer than the former.

Arbitration of exchange is a comparison between the courses of exchange of several places, and determines the most advantageous mode of drawing and remitting bills.

London and Dublin.

Accounts are kept in Dublin as in London, in pounds, shillings, and pence, but the value of these denominations is $\frac{1}{12}$ greater in Dublin than in London. Thus the English shilling is worth 1*s.* 1*d.* Irish, and the English £ is worth £1 1*s.* 8*d.*, Irish. The *par of exchange* is therefore 8⅓ per cent.

Ex. Reduce £159 12*s.* 6*d.* Irish to British money, exchange at 6½ per cent.

$$\begin{array}{ll} 2\,\underline{)\;\;1{\cdot}0} & 12\,\underline{)6\quad} \\ \;\text{£}106{\cdot}5 = \text{£}106\tfrac{1}{2} & 20\,\underline{)12{\cdot}5} \\ & \quad 159{\cdot}625 = \text{£}159\ \ 12s.\ \ 6d. \end{array}$$

$$106{\cdot}5 \quad : \quad 100 \quad :: \quad 159{\cdot}625$$

Whence £149 17*s.* 7¾*d.* the answer.

London and France.

Accounts are kept in France in *francs* and *centimes*, or in *livres*, *sous*, and *deniers*.

20 centimes = 1 decime.
100 centimes = 1 franc.

12 deniers = 1 sou.
20 sous = 1 livre.
3 livres = 1 écu.
80 francs = 81 livres.

Ex. 1. Reduce 4305 francs, 95 centimes into sterling money; exchange at 24 francs, 25 centimes per £ sterling.

fr. fr. £
24·25 : 4305·95 :: 1

Whence £177 11*s*. 3½*d*. the answer.

Ex. 2. Reduce £675 18*s*. 3*d*. to francs and centimes; exchange at 23 francs 15 centimes per £ sterling.

12)3·00
20)18·25
675·9125 = £675 18*s*. 3*d*.

£ £ fr.
1 : 675·9125 :: 23·15

Whence 15647 fr. 37 cent. the answer.

Ex. 3. Reduce 37823 fr., 59 cent. to Irish money; exchange between England and Ireland at 7½ per cent., and between England and France at 24 fr. 51 cent. per £ sterling.

37823·59 fr.
24·51 fr. = £1 English
£100 Eng. = 107·5 Irish

Whence $\frac{37823\cdot59 \times 107\cdot5}{24\cdot51 \times 100}$ = £1658 18*s*. 7*d*. Irish, the answer.

London and Amsterdam.

Accounts are kept at Amsterdam in *florins*, *stivers*, and *pennings*, or in *pounds*, *shillings*, and *pence*, Flemish.

16 pennings = 1 stiver.
20 stivers = 1 florin or guilder.
12 pence, Flemish, or 6 stivers = 1 shilling, Flemish.
20 shillings, Flemish, or 6 florins = 1 pound, Flemish.
2½ florins, or 50 stivers = 1 rix dollar.

Ex. Reduce 219 flr. 17 stiv. currency, to banço, agio at 3¾ per cent.

£ *s*. £ flor. stiv.
103 15 : 100· :: 219 17

or, by decimals—

£ £ flor.
103·75 : 100 :: 219·85

Whence 211 flor. 18 stiv. 1 p. the answer.

By aid of the requisite tables we may solve any cases similar to the above. For this purpose the following tables are given.

Portugal. 1000 reis = 1 milrei: 400 reis = 1 crusado: 4800 reis = 1 moidore: 2½ crusados of exchange = 1 milrei.

Spain. 34 maravedies = 1 real: 8 reals = 1 piastre, or dollar of exchange: 4 piastres = 1 pistole: 375 maravedies = 1 ducat of exchange.

Leghorn and Genoa. 12 denari = 1 soldo: 20 soldi = 1 pezza, or dollar of exchange.

Naples. 10 grains = 1 carlin: 10 carlins = 1 ducat regno.

Vienna. 4 pfennings = 1 creutzer: 60 creutzers = 1 florin or gulden: 90 creutzers or 1½ florins = 1 rix dollar.

St. Petersburgh. 100 copecs = 1 rouble.

Stockholm. 12 pfennings = 1 skilling: 48 skillings = 1 rix dollar.

Copenhagen. 12 pfennings = 1 skilling: 16 skillings = 1 mark: 6 marks = 1 rix dollar.

N.B. The American dollar, and the rix dollar of Vienna, Copenhagen, and Stockholm, are each equal to about 4*s.* 6*d.* British at par.

The East India coin is the rupee = about 2*s.*: a *lac* of rupees = 100,000 rupees, or about £10,000: and a *crore* = 100 lacs.

Ex. A merchant has to remit a sum of money to Amsterdam: the direct exchange is 37*s.* Flemish per £ sterling, but between London and Paris the exchange is 24 francs per £ sterling, and between Paris and Amsterdam it is 54*d.* Flemish for 3 francs: had he better remit direct or through Paris?

We have to find the arbitrated price of £1 sterling through Paris.

£1 sterling

1 sterling = 24 francs

3 francs = 54d. Flemish or 4·5 shillings

$$\frac{24 \times 4{\cdot}5}{3} = e + 4{\cdot}5 = 36s.\ \text{Flemish}$$

or £1 sterling through Paris = 36*s.* Flemish.

It is therefore better to remit direct.

EXAMPLES. LVII.

1. Reduce £288 7*s.* 6*d.* English money to Irish, exchange at 7¾ per cent.

2. Reduce £879 6*s.* 6*d.* Irish to English money, exchange at 11⅝.

3. Reduce £759 13*s.* 4*d.* Irish to English, exchange at par.

4. How much currency can I have in Venice for 1500 ducats banco, agio being 15 per cent.?

5. How much Flemish money will £233 6*s.* 8*d.* be worth, exchange being 34*s.* per £ sterling?

6. How much sterling can I have for 4086 florins, 4 stivers and 6 pennings, banco, supposing £1 to be worth 38 schillings and 2 grotes?

7. Reduce £364 7*s.* 6*d.* into francs and centimes, exchange at 23 livres 10 sous per £ sterling.

8. The course of exchange from London to Madrid is 34*d.* per piastre, and from London to Lisbon 68*d.* per milrei; how many reis should be given for 1 piastre?

9. If the exchange from London to Lisbon be 68*d.* per milrei, and from London to Madrid 34*d.* per piastre, and Madrid advises London that the exchange for Lisbon is 525 reis per piastre, how ought London to draw or remit with advantage, and what would be the profit on £100?

10. When the exchange between England and America is at 80 per cent., and between England and Amsterdam at 36*s.* 4*d.* Flemish per pound English, what is the arbitrated course of exchange between America and Amsterdam?

PAPER No. 24.

1. Find the sum, difference, product, and quotient of $\cdot 7\dot{2}4\dot{5}$ and $8\cdot 2\dot{1}\dot{7}$.

2. Find the simple interest on £345 2*s.* 6*d.* for 3½ yrs. at 5 per cent.

3. What is the commission at 1¼ per cent. on the sale of an estate which realised £15,000; and what amount did the

owner receive after deducting £725 for expenses in addition to the commission?

4. What is the annual income on £34,000, invested in the Eastern Debentures, 6 per cent. at £102?

5. Find the equated time of payment of £200 due at present, £300 due in 11 months, £800 due in 4 months, and £50 due in 2 months.

6. What per cent. would be gained by selling wheat at £12 10*s.* per load, which cost £11 15*s.*?

7. How much cloth at 7*s.* 6*d.* per yard must be given for 2 cwt. 3 qrs. 2 lbs. of tea at 2*s.* per lb.?

8. A, B, and C join in business; A's stock is £20,000, B's £15,000, C's, £25,000, and they gain £2,400 5*s.*; what is each man's share?

9. A wine merchant mixed together 18 gallons of wine at 15*s.* per gallon with 30 gallons at 10*s.*: what was the value of the mixture?

10. Reduce 8935 francs 42 centimes to Irish money, exchange between England and Ireland at 9½ per cent., and between England and France at 22 francs 40 centimes per £ sterling.

CHAIN RULE.

THIS rule solves questions in which several quantities are so connected that a certain number of the first equals a certain number of the second, and so on, and it is required to find how many of the last equal a given number of the first, and so on.

RULE. First put down the term of demand, then arrange under it all the other quantities as equations—observing that each term on the left must be always of the same kind as the one on the right next above it.

Divide the product of all the terms on the right by the product of those on the left.

Ex. If 16 plums are worth 12 pears, and 15 pears are worth 10 apples, how many apples are worth 72 plums?

72 plums
16 plums 12 pears
15 pears 10 apples
$\frac{72\times12\times10}{16\times15}$ $\frac{9\times4\times10}{2\times5}$
36 apples *Ans.* 36 apples.

EXAMPLES. LVIII.

1. If 32 plums are worth 12 pears, and 15 pears are worth 10 apples, how many apples are worth 144 plums?

2. If 12 peaches are worth 84 apples, 8 apples are worth 24 pears, and 15 pears are worth 105 plums, how many plums shall I have for 30 peaches?

3. If 7 oxen are worth 20 sheep, 5 sheep worth 11 hogs, and 3 hogs worth 14 loads of wheat, how many loads of wheat are worth 20 oxen?

4. If 1 lb. of tea is worth $2\frac{1}{2}$ lbs. of coffee, and 1 lb. of coffee is worth $3\frac{1}{2}$ lbs. of sugar, what will be the value of 56 lbs. of tea, when sugar is 7*d.* per lb.?

5. If $\frac{1}{5}$ of a sheep be worth £$\frac{2}{3}$, and $\frac{3}{7}$ of a sheep be worth $\frac{1}{14}$ of an ox, how much must be given for 100 oxen?

6. If 54*d.* at Amsterdam be given for 1 crown of Paris, and 33*s.* 9*d.* at Amsterdam be given for £1 English, what English money is equal to a French crown?

7. How many pears may I have for £2 5*s.*, if 70 almonds be worth 50 chestnuts, 48 chestnuts worth 1 pomegranate, 18 pomegranates worth 28 lemons, 10 lemons worth 25 pears, and 108 almonds cost 9*d.*?

8. If 5 balls of lead weigh as much as 9 of iron, and 3 of iron as much as 7 of marble, how many balls of marble will be equal in weight to 35 balls of lead?

9. If 9 lbs. of tea is worth 27 lbs. of coffee, and coffee be worth 1*s.* 6*d.* per lb., what would be the loss per cent. by exchanging 15 lbs. of sugar for 1 lb. of tea, 7 lbs. of sugar being equal to 1 lb. of coffee?

10. In the Crimean armies there were 40 Russians to every 5 Frenchmen, and 4 English to every 6 Frenchmen, and 8 Turks to every 2 Englishmen. If the Turks had

been left to defend their own territory, how many Russians would there have been to a Turk?

PAPER No. 25.

1. Express in words 72103000721890, and four billions, one million and twenty-seven in figures.

2. Find the greatest common factor of 1323, 3675, and 1029.

3. Find the sum and difference of $8{\cdot}21\dot{7}\dot{3}$ and $7{\cdot}200\dot{1}36\dot{4}$.

4. If 80 men dig a trench 100 yds. long, 10 ft. deep, and 20 ft. wide, in 6 days of 9 hours each, how many men would be required to dig a trench twice the size in one-third of the time?

5. If 8 apples are worth 10 pears, and 3 pears are worth 20 plums, 25 plums 1 peach, and 7 peaches 2*s.* 4*d.*, what would be the value of 10 bushels of apples, the average number of apples being 120 to the bushel?

6. What is the value of a franc in American money, exchange between England and America at 50 per cent., and between England and France at 24 francs 87 centimes per £.

7. If a cubic foot of coal weighs 78 lbs., what extent of coal 7 ft. thick will supply a city of 100,000 inhabitants yearly, if each family of 5 persons consume on an average 3 tons per annum?

8. Multiply 7 ft. 9′ 10″ by 8′ 10″ 4‴.

9. Find the area of a rectangular field, the length of which is 200 yds., and breadth is 20 links.

10. Express 38421 in the common scale in the quaternary scale.

EQUATION OF PAYMENTS.

Equation of payments finds the just time for the payment *at once* of several debts due at *different* times.

Rule. Multiply each debt by its time, and add the products together.

Divide their sum by the sum of all the debts.

Ex. If £100 be due in 3 months, £210 in 2 months, and £160 in 5 months, find the equated time.

£ mths.	
100 × 3	300
210 × 2	420
160 × 5	800
470 the sum of the debts	1520

$\therefore \frac{1520}{470}$ $3\frac{11}{47}$ months, the equated time. *Ans.* $3\frac{11}{47}$ months.

Examples. LIX.

Find the equated times in the following :—

1. £100 due at present, and £600 in 7 months.

2. £300 due in 4 months, £500 in 6 months, and £400 in $10\frac{1}{2}$ months.

3. £350 due at the end of 8 months, and £600 at 18 months.

4. £45 due at 6 months, £70 at 11 months and £75 at 13 months.

5. Of a debt of £1200, one half is due at 18 months, one fourth at 15 months, one sixth at 10 months, and the remainder at 3 months.

6. £66 13*s.* 4*d.* due in 3 months, £33 6*s.* 8*d.* due in 4 months, £100 in 5 months, and £66 13*s.* 4*d.* in 6 months.

7. £500 to be paid as follows :—$\frac{1}{5}$ in ready money, $\frac{1}{3}$ in 3 months, $\frac{1}{5}$ in 4 months, ^{1}[illegible] in 6 months, and the rest in 8 months.

8. £50 to be paid by monthly payments of £5.

9. £1000 to be paid by monthly payments of £50.

10. A debt is to be paid $\frac{1}{2}$ now, and $\frac{1}{20}$ of the remainder every month.

ALLIGATION.

Alligation finds the rate or quality of a mixture from the rates or qualities of the ingredients of which it is made up.

Rule. Multiply the ingredients by their respective rates.

Divide the sum of the products by the sum of the ingredients.

Ex. A wine merchant mixes together 20 gallons of wine at 12*s*. per gallon, 25 gallons at 14*s*., and 36 gallons at 16*s*.: what will be the price of a gallon of the mixture?

$$\begin{array}{ll} 20 \times 12 & = 240 \\ 25 \times 14 & = 350 \\ \underline{36} \times 16 & = \underline{576} \\ 81 \text{ gallons} & = 1166s. \end{array}$$

$\therefore \frac{1166}{81} = 14s.\ 4\frac{1}{3}d.$ price of a gallon of the mixture.

Examples. LX.

1. A grocer mixes 30 lbs. of tea at 6*s*. 8*d*. per lb., with 20 lbs. at 8*s*. 6*d*. per lb.; what is 1 lb. of the mixture worth?

2. If I mix 10 lbs. of tea at 3*s*. per lb., 12 lbs. at 4*s*., and 8 lbs. at 1*s*. 6*d*., what can I sell the mixture at per lb. so as not to lose on the whole?

3. If I mix together 5 cwt. of salt at 7*s*. per cwt., 9 cwt. at 8*s*. 6*d*. per cwt., and 14½ cwt. at 5*s*. 10*d*., at what rate ought I to sell it per lb.?

4. If 5 gallons of spirits at 8*s*. a gallon, 4 gallons at 7*s*. a gallon, 2 gallons at 1*s*. a gallon, and 3 gallons of water be mixed together, what is a gallon of the mixture worth?

5. A farmer mixed together 6 bushels of barley at 3*s*. 6*d*. a bushel, 6 bushels at 4*s*. and 30 bushels at 2*s*.; what did he gain by selling the mixture at 3*s*. 2*d*. per bushel?

6. A wine merchant mixed 50 gallons of wine at 15*s*. a gallon, 20 gallons at 10*s*., 30 gallons at 12*s*. and 40 gallons at 8*s*.: he sold the mixture at 14*s*. per gallon; what was his total gain?

7. How many gallons of water must be mixed with 84 gallons of spirits at 12*s*. 6*d*. a gallon, so that the mixture may be worth only 10*s*. 6*d*. a gallon?

8. I purchased £10000 stock in the 3 per cents. at 85, £12000 stock in Great Northerns at 120, and 5 hundred pound shares in the Great Western at 65, what was the average price of my stock?

9. If 2 cwt. of sugar be sold at 18*s*. 6*d*. per cwt., 3 cwt.

at 19*s*. 10*d*., and 5 at £1 per cwt., what is the average value per cwt.?

10. A man mixes 30 tons of coal at 21*s*. per ton, with 60 tons at 19*s*. and 10 tons at 23*s*.; at what price per ton must he sell the mixture, so as to gain 25 per cent.?

TARE AND TRET.

Tare is an allowance for the weight of the box, barrel, &c. in which goods are conveyed.

Tret is an allowance of 4 lbs. in every 104 lbs. for waste, dust, &c.

Cloff is an allowance, after tare and tret are deducted, of 2 lb. in every 3 cwt., that the weight may hold good when sold by retail.

When tare only is deducted from the *gross* weight, the remainder is called *suttle*.

When all allowances have been made the remainder is called the *neat* or *net* weight.

Ex. 1. What is the net weight of 7 barrels of potash, each weighing 201 lb., tare being 10 lbs. per cwt.?

$$\begin{array}{r} \text{lbs.} \\ 201 \\ 7 \\ \hline 1407 \text{ lb.} \end{array}$$

The net weight of 112 lb. is 112 lb. − 10 lb. = 102 lb.

$$\begin{array}{ccccc} \text{lb.} & & \text{lb.} & & \text{lb.} \\ \cancel{112} & : & \cancel{1407} & :: & \cancel{102} \\ \cancel{56} & & 201 & & 51 \\ 8 & & 51 & & \\ & & \overline{201} & & \\ & & 1005 & & \\ & & 8\overline{)10251} & & \\ & & \overline{1281 \text{ lbs. } 6 \text{ oz. net weight.}} & & \end{array}$$

Ans. 1281 lbs. 6 ozs.

Ex. 2. Find the net weight of 39 cwt. 3 qrs. 21 lbs., tare 18 lbs. per cwt., tret and cloff as usual.

	cwt.	qrs.	lbs.
	39	3	21
16 lbs. = $\frac{1}{7}$ 1 cwt.	5	2	23
2 lbs. = $\frac{1}{8}$ 16 lbs.		2	24
Tare	6	1	19
Suttle	33	2	2
4 lbs. = $\frac{1}{26}$ of 104 lbs.	1	1	4
	32	0	26
2 lbs. = $\frac{1}{168}$ of 3 cwt			22
	32	0	4 net weight.

Ans. 32 cwt. 0 qrs. 4 lbs.

EXAMPLES. LXI.

1. What is the net weight of 9 casks of soap weighing 28 cwt. 0 qrs. 26 lbs., the tare being 472 lbs.?

2. What is the net weight of 12 hhds. of tobacco, each weighing 5 cwt. 3 qrs. 14 lbs. : tare per hhd. 97 lbs.?

3. What is the net weight of 7 barrels of figs, each weighing 2 cwt. 1 qr. 12 lbs. : tare 21 lbs. per cwt.?

4. What is the net weight of 15 casks of tallow, each weighing 6 cwt. 2 qrs. 12 lbs. : tare being 12 lbs. per cwt. and tret as usual?

5. What is the net weight of 7 hhds. of tobacco, each 5 cwt. 2 qrs. 7 lbs. : tare 8 lbs. per cwt., tret and cloff as usual?

6. What is the net weight of 15 cwt. 3 qrs. 20 lbs. of tobacco, tare 7 lbs. per cwt., tret 4 lbs. per 104 lbs., and cloff 2 lbs. for every 3 cwt.?

7. What is the net value of 6 chests of tea, weighing 6 cwt. 0 qrs. $4\frac{1}{8}$ lbs. at 7*s.* 3*d.* per cwt., tare 25 lbs. per chest?

8. What is the net value of 8 hhds. of spirits, each containing 52 gallons and weighing 8 cwt. 3 qrs. 24 lbs. at 8*s.* 9*d.* per gallon : tare $17\frac{1}{2}$ lbs. per cwt.?

9. What is the value of 10 bales of pepper, each weighing 2 cwt. 3 qrs. 12 lbs., at 1*s.* $2\frac{3}{4}$*d.* per lb. : tare 4 lbs. per bale, and tret 4 lbs. in 104 lbs.?

10. What quantity of tea should be given for 4 cwt. 2 qrs. 12 lbs., of sugar at 4*d.* per lb., the tea being valued at 3*s.* 4*d.* per lb., allowing tret on sugar?

INVOLUTION.

If a number be multiplied by itself, and the product by the same, and so on, to any assigned number of products, the process is called *Involution*. The number of times which the number has been used in the multiplication expresses the *power* to which it is raised. Thus:

2 or 2 = the 1st power of 2.
2×2 or 4 = the 2nd power of 2, or the square of 2.
$2 \times 2 \times 2$ or 8 = the 3rd power of 2, or the cube of 2.
$2 \times 2 \times 2 \times 2$ or 16 = the 4th power of 2.
$2 \times 2 \times 2 \times 2 \times 2$ or 32 = the 5th power of 2.

And so on.

This operation is concisely denoted by small figures called *indices*, placed to the right of the numbers, thus, 2^1, 2^2, 2^3, 2^4, &c., severally denote the 1st, 2nd, 3rd, 4th, &c., powers of 2.

By multiplication we find the following tables:—

1. *Table of Squares.*

$1^2 = 1$
$2^2 = 4$
$3^2 = 9$
$4^2 = 16$
$5^2 = 25$
$6^2 = 36$
$7^2 = 49$
$8^2 = 64$
$9^2 = 81$
$10^2 = 100$
$11^2 = 121$
$12^2 = 144$

2. *Table of Cubes.*

$1^3 = 1$
$2^3 = 8$
$3^3 = 27$
$4^3 = 64$
$5^3 = 125$
$6^3 = 216$
$7^3 = 343$
$8^3 = 512$
$9^3 = 729$
$10^3 = 1000$
$11^3 = 1331$
$12^3 = 1728$

To raise a *fraction* to any power, raise both the numerator and the denominator to that power.

Ex. Raise $\frac{3}{4}$ to the 3rd power.

$$\left(\frac{3}{4}\right)^3 = \frac{3^3}{4^3} = \frac{27}{64}.$$

By raising a *decimal* to the 2nd and 3rd powers, we shall find that the square of a decimal will have 2, 4, 6, 8, &c., decimal places, and the cube 3, 6, 9, 12, &c., decimal places, according as the given decimal has 1, 2, 3, 4, &c., decimal places.

EXAMPLES. LXII.

Find the value of:

1. 7^2.
2. 100^2.
3. 724^2.
4. 8^3.
5. 25^3.
6. 6^4.
7. 9^5.
8. $(\frac{7}{8})^2$.
9. $(\frac{12}{17})^3$.
10. $(3\frac{1}{4})^4$.

EVOLUTION.

EVOLUTION is the reverse of involution, and means *the extraction of the root of a certain number*, or finding what number raised to a certain power will produce a given number.

The roots are usually represented by $\sqrt{}$, or by fractional indices. Thus:

$\sqrt{9}$ or $9^{\frac{1}{2}}$ means the 2nd, or square root of 9.
$\sqrt[3]{27}$ or $27^{\frac{1}{3}}$ „ 3rd, or cube root of 27.
$\sqrt[4]{81}$ or $27^{\frac{1}{4}}$ „ 4th root of 81.

SQUARE ROOT.

THE *square root of a number is that number which multiplied by itself will produce the number.* Thus, the square root of 9 is 3; of 64 is 8.

To find the square root of any number.

RULE. Put a point over the unit's place and over every alternate figure.

Find the greatest square number contained in the first period to the left, and put the square root of that number on the right as in division. Square the root thus found, and place that square under the first period. Subtract, and to the remainder bring down the next period for a dividend.

Double the root already found, and place the product for a divisor.

Divide the dividend exclusive of the figure on its right hand by the root thus doubled, and place the quotient in the root and in the divisor.

Multiply, and subtract as in division; bring down the next period, and so on until the work is completed.

Ex. Extract the square root of 288369.

```
       28̇83̇69̇(537
       25
    103)383
         309
   1067)7469
         7469                       Ans. 537.
```

To extract the square root of a decimal.

Rule. Add a nought to the right if the number of decimal places be odd.

Put a point over the unit's place and over every alternate figure to the right and left.

The number of decimals in the root will equal the number of decimal periods.

The reason of the pointing will appear if we consider that

$$(\cdot 1)^2=\cdot 01.$$
$$(.9)^2=\cdot 81.$$
$$(\cdot 01)^2=\cdot 0001.$$
$$(\cdot 99)^2=\cdot 9801.$$

Ex. Extract the square root of 104·793.

```
        104̇·79̇30̇(10·23
        1
   202)   479
          404
    2043)  7530
           6129
           1401                     Ans. 10·23 &c.
```

To extract the square root of a fraction.

Rule. Find the square root of its numerator and denominator separately.

Ex. Find the square root of $\frac{144}{169}$.

$$\sqrt{\left(\tfrac{144}{169}\right)} = \frac{\sqrt{144}}{\sqrt{169}} = \tfrac{12}{13}.$$

If the numerator and denominator be not complete squares, reduce the fraction to a decimal, and find the square root of that decimal.

Ex. Find the square root of $\frac{31957}{25}$.

$$\sqrt{\tfrac{31957}{25}} = \sqrt{1278{\cdot}28} = 35{\cdot}753 \text{ \&c.}$$

Examples. LXIII.

Find the square root of—

1. 256.
2. 21056.
3. 998001.
4. 5774409.
5. 33·64.
6. ·005329.
7. ·21374.
8. ·000576.
9. $16\frac{4}{25}$.
10. $8\frac{5}{7}$.

CUBE ROOT.

The cube root of a number is that number which, multiplied by itself thrice, will produce the number. Thus the cube root of 27 is 3; of 125 is 5.

To extract the cube root of a given number.

Rule. Put a point over the unit's place, and every third figure.

Find the greatest cube contained in the first period on the left, and place its root on the right.

Put the cube of this root under the first period, subtract and to the remainder bring down the next period for a dividend.

To find a divisor, square the root thus found and multiply that square by 300.

Determine by trial with the divisor, what the next figure must be, and put it in the root.

Multiply the divisor by the last figure in the root.

Square the last figure, multiply it by 30, and by the preceding root.

Cube the last figure.

Add up, and subtract, and bring down the next period, and so on, until the work is completed.

Ex. Extract the cube root of 76765625.

$$\begin{array}{rr}
 & 76765625(425 \\
4^3= & 64 \\
4^2\times 300=4800) & \overline{12765} \\
4^2\times 300\times 2= & \overline{9600} \\
2^2\times 30\times 4= & 480 \\
2^3= & 8 \\
 & \overline{10088} \\
(42)^2\times 300=529200) & \overline{2677625} \\
(42)^2\times 300\times 5= & \overline{2646000} \\
5^2\times 30\times 42= & 31500 \\
5^3= & 125 \\
 & \overline{2677625}
\end{array}$$

To extract the cube root of a decimal.

Add ciphers, if necessary, to make the decimal consist of 3, 6, 9, &c., places, and point off every third figure to the right of the unit's place.

The number of decimals in the root will equal that of the decimal periods.

Ex. Find the cube root of 28·25.

$$\begin{array}{rr}
 & 28\cdot 250000(3\cdot 04 \\
3^3= & 27 \\
3^2\times 300=2700) & \overline{1250} \\
(30)^2\times 300=270000) & \overline{1250000} \\
(30)^2\times 300\times 4= & \overline{1080000} \\
4^2\times 30\times 30= & 14400 \\
4^3= & 64 \\
 & \overline{1094464} \\
 & \overline{155536000}
\end{array}$$

Ans. 3·04, &c.

and so on.

To extract the cube root of a fraction.

Find the cube root of its numerator and denominator separately, or if they be not complete cubes, reduce it to a decimal, of which extract the root as above.

The reason for pointing every third figure is as follows:

$$1^3=1.$$
$$10^3=1{,}000.$$
$$100^3=1{,}000{,}000,\ \&c.$$
$$(\cdot 1)^3=\cdot 001.$$
$$(\cdot 9)^3=\cdot 729.$$
$$(\cdot 01)^3=\cdot 000001.$$
$$(\cdot 99)^3=\cdot 970299,\ \&c.$$

Hence we see that the cube of one figure cannot exceed three figures, and the cube of two figures cannot exceed six figures, and so on: also that the cube of every decimal consists of three, six, or nine, &c. places, so that by putting a point over the unit's place, and over every third figure to the right and left, we divide the given number into periods of three figures, each period answering to one figure in the root.

EXAMPLES. LXIV.

Extract the cube root of—

1. 1728.
2. 15625.
3. 97336.
4. 32461759.
5. 64964808.
6. 1191·016.
7. 1141166·125.
8. $\frac{64}{343}$.
9. $49\frac{8}{27}$.
10. $7558\frac{197}{512}$.

PAPER No. 26.

1. How often is £49 3*s*. 1*d*. contained in £16121 17*s*. 8*d*.?

2. If £731 15*s*. be the rent for 365 ac. 3 rds. 20 pls., what is the rent of 200 acres?

3. If 15 men in 12 days could mow 180 acres, how many men would be required to mow a field of 40 acres in 6 days?

4. Find the simple interest and amount of £725 10*s*. for 5 yrs. at 4 per cent.?

5. Find the discount and present worth of £250 due 6 months hence at 4 per cent.

6. At what rate per cent. would £1000 become £1200 in 4 yrs.?

7. Three persons embark in trade, A puts in £1000, for 6 months, B £500 for 9 months, and C £1500 for 12 months, they gain £1000; what should be the share of each?

8. Find the square root of ·005329.

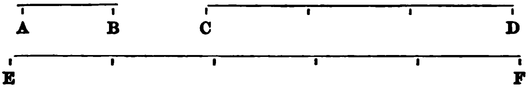
9. Find the cube root of 970299.

10. Reduce to simple forms $\sqrt{\frac{9}{49}}$, $7\sqrt{25}$, $\sqrt[3]{\frac{27}{64}}$, $5\sqrt[3]{8}$, $(\frac{5}{6})^2$, $(\frac{3}{4})^3$.

LINEAR MEASURE.

THE *unit* of linear measure is a straight line of certain length, as *one yard*, *one foot*, *one inch*.

By comparison with this unit the magnitude of other lines may be determined. Thus if A B be the linear unit and denoted by 1; a line C D which contains A B 3 times will be denoted by 3; and E F which contains it 5 times, will be denoted by 5, or if A B$=1$, then C D$=3$ and E F$=5$.



RULE 1. *Right-angled triangle.* The hypothenuse equals the square root of the sum of the squares of the sides.

2. *Right-angled triangle.* One side equals the square root of the square of the hypothenuse minus the square of the other side.

3. *Circle.* The circumference equals the diameter (or twice the radius) multiplied by 3·14159, nearly.

4. *Circle.* The diameter equals the circumference divided by 3·14159. Radius equals half the diameter.

Ex. 1. Find the hypothenuse of a right-angled triangle whose sides are 3 and 4 ft.

$$\text{Hypothenuse} = \sqrt{3^2+4^2} = \sqrt{9+16}$$
$$= \sqrt{25}$$
$$= 5 \text{ ft.} \qquad \textit{Ans. } 5 \text{ ft.}$$

Ex. 2. Find the radius of a circle whose circumference is 40 yds.

$$2 \text{ rad.} = \frac{40}{3{\cdot}14159} = 12{\cdot}7324$$
$$\therefore \text{ rad.} = 6{\cdot}3662 \text{ yards.}$$

Examples. LXV.

1. Find the circumference of a circle whose diameter is 50 feet.

2, The circumference of a circle is 40·8407 inches; find the radius,

3. If the diameter of a circular cask be 2 ft. 9 in., find the length of a hoop for it.

4. If the girth of a tree be 12 ft. 5 in., what is its diameter?

4, The length of $\frac{1}{360}$ of the earth's circumference is about $69\frac{1}{22}$ miles; what is the earth's diameter, assuming that $\frac{7}{22}$ expresses the ratio of the diameter of a circle to its circumference?

6. A line stretched from the top of a spire 50 feet from its base, measured 50 yards; how high was the spire?

7. A precipice 375 feet high stands close to a river, and a line of 625 feet reaches from the top of the precipice to the opposite bank; what is the breadth of the river?

8. What is the difference between the circumferences of two circles, the diameters of which are 6 feet and 5·24 feet respectively?

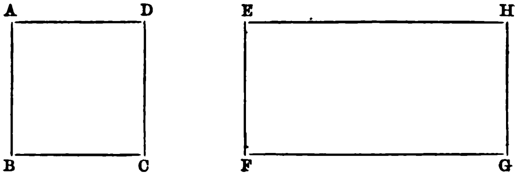
9. In measuring a circular piece of timber in order to place an iron bolt through the centre, an error in measurement caused the bolt, 32 inches in length, to be $1\frac{1}{2}$ inches too short, what was the correct measurement?

10. The rope of a giant stride 10 ft. long, when pulled 6 ft. from the pole, was found to be 4 ft. from the ground; what was the height of the pole?

SUPERFICIAL MEASURE.

A *superficies* has length and breadth.

The *unit* of superficial measure is a square surface



whereof each side equals in length the lineal unit: thus if B C, A B (which may be regarded as the length and breadth) be each *one yard*, *one foot*, or *one inch*: the superficial unit A B C D, will be *one yard square*, *one foot square*, or *one inch square.*

The area of a rectangular parallelogram will be represented arithmetically, by the product of two of its adjacent sides.

Let E F G H be a rectangular parallelogram, and let E F contain A B five times, and F G contain it six times, by dividing E F into those five parts, and F G into six, and drawing through each of the points thus made, lines parallel to E H and H G, E F G H will be divided into 30 figures, each equal to A B C D ∴ if we call A B C D=1 : E F G H=30 × A B C D =30 × 1=5 × 6.

Cor.—If E F and F G each=12 inches, then E F G H=12 × 12=144 inches: but E F G H is in this case a square foot.

∴ one square foot=144 square inches: similarly,

1 square yard=9 square feet.

RULES FOR FINDING AREAS.

1. *Parallelogram.* The area equals the base multiplied by the perpendicular altitude.

2. *Triangle.* The area equals half the product of the base and perpendicular altitude.

3. *Triangle.* From half the sum of the three sides subtract each side separately, multiply the half sum by these three remainders, and extract the square root of the product.

4. *Trapezium.* The area equals half the product of either diagonal, and the sum of the perpendiculars let fall on it from the opposite angles.

5. *Circle.* The area equals the square of the radius multiplied by 3·14159 nearly.

6. *Circle.* The area equals half the radius multiplied by the subtending arc.

7. *Ellipse.* The area equals the product of the semi-axes multiplied by 3·14159 nearly.

Ex. 1. What is the area of a circle whose radius is 2 ft.?

$$\text{Area} = 4 \times 3{\cdot}14159 = 12{\cdot}56636 \text{ sq. ft. nearly.}$$

Ex. 2. Find the area of a triangle whose base is 8 ft., and perpendicular altitude is 3 ft.

$$\text{Area} = \frac{8 \times 3}{2} \text{ feet} = 12 \text{ square feet.}$$

EXAMPLES. LXVI.

1. Find the area of a triangle whose base is 145 feet, and perpendicular height 74 feet.

2. Find the area of a circular table whose diameter is 5 ft. 8 in.

3. The sides of a triangle are 16·6, 18·32 and 28·6: find its area.

4. If the diagonal of a trapezium be 498 yards, and the perpendiculars let fall upon it from the opposite angles be 10·8 and 18·8 yards: what is its area?

5. The semi axes of an ellipse are 25 and 49; find the radius of a circle of equal area.

6. The base of a triangle is 14·1 yards, and its area 64·86 yards: find its perpendicular height.

7. The side of an equilateral triangle is 6: find its area.

8. The two equal sides of an isosceles triangle are 12 feet and the base is 8 feet; find its area.

9. The radii of two concentric circles are 10 and 12 yards; find the space included between them.

10. What is the area of an elliptic ceiling, the axes of which are 33 ft. 5 in., and 20 ft. 3 in.?

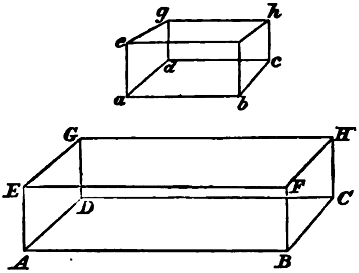
SOLID MEASURE.

A SOLID is that which has length, breadth and height.

A unit of solid measure, is a rectangular parallelopiped whose length, breadth, and height are each one lineal unit, as *one yard*, *one foot*, *one inch*; in which case the parallelopiped is called, a *cubic yard*, a *cubic foot* or a *cubic inch*.

The solid content of a rectangular parallelopiped will be numerically represented by the product of its length, breadth, and height.

For let $a\,h$ be the cubic unit, and A H another rectangular parallelopiped, whose length A B $=5$ lineal units, height A E $=3$ lineal units, and breadth A D $=2$ lineal units; by dividing A B into 5 parts, A D into 2, and A E into 3, and completing the figures, we should have 30 parallelopipeds each equal to $a\,h$: and $\therefore$ calling $a\,h=1$, we should have A H $=30 \times a\,h=30 \times 1=5 \times 3 \times 2=$length × breadth × height.



Cor.—If the sides be each equal to 3 ft., A H $=3 \times 3 \times 3=27$ solid feet: but A H in this case=one solid yard.

$\therefore$ 1 solid yard=27 cubic feet.

Similarly 1 cubic foot=1728 cubic inches.

RULES FOR FINDING SOLID CONTENT.

1. *Parallelopiped.* The content equals the area of the base multiplied by the perpendicular height.

2. *Prism and Cylinder.* The content equals the area of the base multiplied by perpendicular height.

3. *Pyramid and Cone.* The content is equal to the area of the base, multiplied by one-third of the perpendicular height.

4. *Sphere or Globe.* The content is equal to the cube of the radius multiplied by 4·18879, nearly.

Ex. Find the solid content of a rectangular piece of timber 2 feet thick, 3 wide, and 6 long.

Solid content $= 2 \times 3 \times 6 = 36$ solid ft.

EXAMPLES. LXVII.

1. Find the solid content of a parallelopiped whose length is 2 ft. 3 in., width 1 ft. 7 in., and depth 9 in. 4″.

2. The edges of a cube being 2 ft. 8 in., what is its solid content?

3. What is the solid content of a piece of timber, the length of which is 22 ft. 3 in., and the mean breadth and thickness each 1 ft. 3 in.; the solid content being the product of the length, mean breadth, and mean thickness?

4. Find the solid content of a cylinder, of which the length is 12 ft. 11 in., and the circumference 5 ft. 3 in.

5. Find the solid content of a globe, of which the diameter is 3 ft.

6. Find the content of a piece of square timber, its length being 20 ft., and its mean breadth and thickness, each 18 in.

7. The height of the largest pyramid is 477 ft., and each side of its base, which is a square, is 720 ft.; find the solid content.

8. Find the solid content of three globes, whose diameters are 12, 15, and 21 inches respectively.

9. Find the content of a mast, its length being 37 ft. 6 in., and its mean girth 50½ in.

10. How many cubic inches are there in a conical sugar-loaf, of which the perpendicular height is 16·3 in., and the diameter of the base 6¼ in.; also what is the weight of a cubic inch, and the bulk of an oz. of such sugar, the weight of the loaf being 9 lbs. 14 ozs.?

PAPER No. 27.

1. Simplify $\frac{(\cdot005+7\cdot24)\cdot4}{\frac{1}{2}(\cdot21-\cdot06)}$.

2. A man bought 180 oranges at 2 a penny, and 180 more at 3 a penny; after which he sold them at 5 for 2*d.*: did he gain or lose, and how much?

3. What income would arise from £2000 invested in the 4 per cents. at £80 12*s.* 6*d.* per £100 stock, allowing brokerage?

4. Reduce £125 6*s.* to florins and stivers, exchange at 12 florins 4 stivers current per £ sterling.

5. Extract the square root of 549·9025.

6. Extract the square root of 9$\frac{1}{6}$ to three places of decimals.

7. If the girth of a tree be 12ft. 5 in., what is its diameter?

8. The side of an equilateral triangle is 8: find its area.

9. Find the content of a log of timber, its length being 25$\frac{1}{2}$ feet, and its mean breadth and thickness being each 20 inches.

10. A cellar is 12 feet in length, breadth, and depth, how many solid feet were dug out?

DUODECIMALS.

Duodecimals is a convenient method of computing small areas and solid contents, used by artificers to estimate work done.

The dimensions are usually taken in yards, feet, inches, parts, &c., decreasing from left to right in a twelvefold proportion, the inches, parts, &c., are termed primes, seconds, thirds, &c., and are denoted by ′, ″, ‴, &c.; thus 20 ft., 9′, 6″, 4‴, means 20ft. 9 in. 6 seconds, 4 thirds.

Glazing and masons' flat work &c., are measured by the square foot; painting, paving, plastering, &c., by the square yard; flooring, roofing, &c., by the square of 100 ft. Brickwork is measured by the rod of 16$\frac{1}{2}$ ft., and 272$\frac{1}{4}$ square
brickwork.

MULTIPLICATION.

Rule. Write the terms of the multiplier under the corresponding terms of the multiplicand.

Multiply every term in the multiplicand, beginning at the lowest, by each term in the multiplier beginning at the highest.

Divide each product, except that which is feet, by 12, and place the remainder under the multiplicand when the multiplier is feet; one place removed to the right when it is primes; two places when it is seconds; three when it is thirds; and so on, observing to add the quotient to the next product.

The sum of these products will be the answer.

Ex. 1. Multiply 8 ft. 6′ 9″ by 7 ft. 3′ 3″.

ft.	′	″		
8	6	9		
7	3	3		
59	11	3		
2	1	8	3	
	2	1	8	3
62	3	0	11	3

Ans. 62 sq. ft. 3′ 0″ 11‴ 3⁗.

Ex. 2. Find the solid content of a rectangular solid, whose length is 2 ft. 3 in., width 1 ft. 7 in., and depth 9 in. 4″.

ft.	′		
2	3		
1	7		
2	3		
1	3	9	
3	6	9	
	9	4	
2	8	0	9
	1	2	3
2	9	3	0

Ans. 2 cub. ft. 9′ 3″ 0‴.

Examples. LXVIII.

Multiply :—

	ft.	in.		ft.	in.
1.	7	9	by	3	6
2.	8	5	„	4	7
3.	9	8	„	7	6

Multiply :—

	ft.	in.			ft.	in.	
4.	8	1		,,	3	5	
5.	7	6		,,	5	9	
6.	75	7		,,	9	8	
7.	7	5	9″	,,	3	5	3″
8.	10	4	5″	,,	7	8	6″
9.	311	4	7″	,,	36	7	5″
10.	331	7	3″	,,	9	3	6″

EXAMPLES. LXIX.

1. Find the area of a floor, its length being 15 ft. 9′ 8″, and width 12 ft. 5′.

2. Find the area of a parallelogram, whose adjacent sides are 8 ft. 6′ 9″ and 7 ft. 3′ 3″.

3. How many square feet of glass are there in 4 windows, each measuring 5 ft. 7′ in height and 3 ft. 5′ in width?

4. What is the area of a piece of wainscoting that is 8 ft. 3′ in length and 6 ft. 6 in. broad?

5. Find the area of a board 10 ft. 3 in. long and 18 in. broad.

6. Find the expense of ceiling a room at 6*d.* a yard, the length being 20 ft. 9 in. and breadth 15 ft. 4 in.

7. Find the expense of paving a yard, which is 30 ft. 10 in. long and 12 ft. 11 in. broad, at 13*d.* per square foot.

8. How many bricks, 9 in. long, 4½ in. wide, and 3 in. thick, are there in a wall 12 ft. long, 6 ft. 9 in. high, and a brick and a half thick?

9. How many tons of gravel will it take to gravel a garden, the walks of which are 320 ft. long and 3 ft. broad, if 1 cwt. covers 12 sq. ft.?

10. How many square inches of paper would it take to cover the surface of a 36 in. globe?

GAUGING.

Liquids are measured by the imperial gallon, which is equal to 277·274 cubic inches; therefore, to find the number of gallons a vessel contains, divide its solid content by 277·274.

$$\text{And number of gallons} = \frac{15360}{277 \cdot 274}$$
$$\text{,,} \qquad \text{,,} \qquad = 55 \cdot 3964$$
$$\text{,,} \qquad \text{,,} \qquad = 55 \text{ gal. } 1 \text{ qt. } 1 \text{ pt.}$$

Ex. What number of gallons are there in a cistern whose length is 40 in., breadth 24, and depth 16?

$$\text{Here solid content} = 40 \times 24 \times 16$$
$$= 15360 \text{ cub. in.}$$

$$\text{No. of gallons} = \frac{15360}{277 \cdot 274}$$
$$= 55 \cdot 3964$$
$$= 55 \text{ gal. } 1 \text{ qt. } 1 \text{ pt.}$$

Malt and corn, &c., are estimated by the imperial bushel, containing 2218·192 cub. in.; therefore to find the number of bushels, find the solid content, and divide it by 2218·192.

Examples. LXX.

1. Find the content in imperial gallons of a rectangular water cistern, of which the length is 13 ft. 7 in., and breadth 12 ft. 4 in., depth 7 ft. 6 in.

2. How many times may a conical wine glass 2 ft. 3 in. in diameter at the mouth, and 2 in. deep, be filled out of a bottle containing $\frac{1}{6}$ of an imperial gallon of wine?

3. How many gallons are there in a cubic foot?

4. The length of a cistern is 169 in., and the breadth is 125 in.; how many gallons does it contain, the liquor being 4 in. deep?

5. What is the content of a cylindrical vessel, the radius of whose base is 20 in., and height 54 in.?

6. How many bushels of malt are there on a floor $5\frac{1}{2}$ ft. by 4 ft. when its depth is 14 in.?

7. How many bushels are contained in a cubic yard?

8. The length of a cistern is 124 in. and breadth 100 in.; it contained 400 gallons, what was its breadth?

9. How many times may a conical bottle 3·5 in. in diameter at the mouth, and 8 in. deep, be filled from a rectangular cistern of which the length is 74 in., breadth 21 in., and depth 15 in.?

10. How many bushels of corn would there be on a floor 20 ft. by 10 ft., the depth of one end being 14 in., and at the other 16 in., the rise being regular?

PAPER No. 28.

1. Divide $3\cdot4\dot{1}\dot{5}$ by $7\cdot23\dot{4}$.

2. Find the value of 2 cwt. 3 qrs. 7 lbs., by practice, at £2 7*s.* 6*d.* per cwt.

3. What would be the difference made in my income by selling out £10000 stock in the 3 per cents. at 94⅞, and investing in the North British 4 per cents. at 105?

4. Find the equated time of payment of £300 due 6 months hence, £700 due at 8 months, and £200 due at present.

5. If by selling an article at 5*s.* 6*d.* I lose 10 per cent., what must I sell it for in order to gain 5 per cent.?

6. C has nutmegs worth 8*s.* 6*d.* ready money, but in barter will have 10*s.*; D has tobacco worth 9*d.* per lb. ready money; how must he rate it at per lb., that his profit may be equivalent, and what quantity of nutmegs must be given for 12 cwt. 1 qr. 18 lbs. of tobacco?

7. Find the net weight of 8 cwt. 2 qrs. after allowing 2 lbs. per cwt. for tare, tret, and cloff as customary.

8. Divide 3770 into 4 parts, which shall be to one another as the numbers 4, 5, 9, and 11.

9. What is the worth of 8 squares of glass, each measuring 4 ft. 10 in. long, and 2 ft. 10 in. broad, at 4½ per foot?

10. What is the content of a cylindrical vessel, the radius of whose base is 20 in., and height 54 in.?

LAND SURVEYING.

Land is measured by Gunter's chain, which is 4 pls. or 22 yds, long, and divided into 100 equal parts called links.

Since an acre is a rectangular area, whose length is 40 pls. and breadth 4 pls., it will equal 40 pls. × 4 pls. = 1000 links × 100 links = 100000 square links, and hence if any superficial content be expressed in links, this divided by 100000 will give the number of acres.

A pole = $5\frac{1}{2}$ yards or 25 links.
A square pole = $30\frac{1}{4}$ square yards or 625 square links.
Rood = 1210 square yards or 25000 square links.
Acre = 4840 square yards or 100000 square links.

Hence a square mile:

$$=1760\times1760 \text{ yards}=3097600 \text{ square yards.}$$

$$=\frac{3097600}{4840} \text{ acres}=640 \text{ acres.}$$

Ex. Find the area of a rectangular field whose length is 25 chains, 8 links, and breadth 14 chains, 75 links.

$$\begin{array}{r}
25 \text{ ch. } 8 \text{ links}=2508 \text{ links.}\\
14 \text{ ch. } 75 \text{ links}=\underline{1475} \text{ links.}\\
12540\phantom{\text{ links.}}\\
17556\phantom{0\text{ links.}}\\
10032\phantom{00\text{ links.}}\\
\underline{2508}\phantom{000\text{ links.}}\\
100000\overline{)3699300}\phantom{\text{ links.}}\\
\overline{36{\cdot}99300} \text{ ac.}\\
\underline{4}\phantom{\text{ ac.}}\\
3{\cdot}97200 \text{ rds.}\\
\underline{40}\phantom{\text{ rds.}}\\
38{\cdot}88000 \text{ pls.}
\end{array}$$

∴ the area of the field = 36 ac. 3 rds. 39 pls. nearly.

Ans. 36 ac. 3 rds. 30 pls.

Examples. LXXI.

1. Find the content of a rectangular field, the length being 37 chs. 50 links, and breadth 10 chs. 5 links.

2. What is the content of a rectangular field, the length being 13 chs. 75 links, and the breadth 12 chs. 10 links?

3. Find the area of a square field, whose side is $10\frac{1}{2}$ chs.

4. The base of a triangular field is 16 chs. 3 pls., and its perpendicular 6 chs. 2 pls.; what number of acres does it contain?

5. The sides of a triangular field are 380, 420, and 765 yards; how many acres does it contain?

6. What is the length of the side of a square field comprising 2 ac. 4 pls.?

7. Two acres of land are to be cut from a rectangular field, whose breadth is 2 chs. 50 links, by a line parallel to it; find the length of the plot?

8. The length of a rectangular field is 15 perches; find its breadth, so that it may contain an acre.

9. If 3 ac. of land are taken from a field whose length is 18 chs., and breadth 25 chs., how much would the remainder measure?

10. A square field contains 27 ac.; find its length.

To express a number in a given scale.

Rule. Divide the given number by the given local value, and arrange the remainders one after the other, placing the first in the unit's place.

Ex. 1. Express 375 in the common scale, in the *septenary* scale.

7)375
7)53-4
7)7-4
7)1-0
7)0-1

∴ 1044 is the number required. *Ans.* 1044.

Ex. 2. Reduce 435 whose local value is 6, to an equivalent number whose local value is 4.

4)435
4)105-3
4)14-1
2)2-2
0-2

∴ 2213 is the number required. *Ans.* 2213.

Addition, subtraction, multiplication, and *division,* are performed in any scale, in the same way as in the common scale, except that we carry or borrow so many 2, 3, 4, &c., according as the scale is binary, ternary, quaternary, &c.

Add in the quaternary scale.

$$\begin{array}{r} 32123 \\ 21003 \\ 33012 \\ 22033 \\ 31102 \\ \hline 332011 \end{array}$$

Ans. 332011.

Subtract in the duodenary scale.

$$\begin{array}{r} 7t348 \\ 5e6t4 \\ \hline 1t864 \end{array}$$

Ans. 1t864.

Multiply 68 and 71 in the undenary scale.

$$\begin{array}{r} 68 \\ 71 \\ \hline 68 \\ 431 \\ \hline 4378 \end{array}$$

Ans. 4378.

Divide in the senary scale 435 by 4.

$$\begin{array}{r} 4\overline{)435} \\ 105\cdot3 \end{array}$$

EXAMPLES. LXXII.

1. Express 721 in the common scale in the septenary scale.

2. Reduce 475, whose local value is 5, to an equivalent number whose local value is 4.

3. Express 1724 in the common scale in the ternary scale.

4. Add in the duodenary scale 42t50, 827et, 74109, and ett09.

5. Subtract 82134 and 5eet0 in the duodenary scale.

6. Multiply 721 and 81 in the undenary scale.

7. Divide in the senary scale 2130 by 4.

8. By how much does 3212 in the duodenary scale exceed 32123 in the undenary scale?

9. Multiply 840 in the duodenary scale by 4te.

10. Which is the greater, 21745 in the common scale, or 82175 in the binary scale?

PAPER No. 29.

1. Simplify $\dfrac{1\frac{1}{5}\left(\frac{2}{3}-\frac{4}{6}\right)+\frac{1}{8}\left(\frac{11}{17} \text{ of } \frac{34}{48}-\frac{7}{8}\right)}{2\,(\cdot 25-3\cdot\dot{3})-\frac{1}{5}\,(\cdot 217+\cdot 383)}$.

2. What fraction is $\frac{1}{5}$ of $\frac{2}{3}$ of 2 cwt. 3 qrs. 4 lbs., of ·24 of 7·25 tons?

3. If I buy 14 sheep for £28, and sell 6 of them for 36*s.* each, what must I sell the remainder at per head, so as to gain £1 4*s.* by the transaction?

4. If 1560 men on full rations consume 441 qrs. of wheat in 119 days, how many men on half rations will consume 874 qrs. in 57 days?

5. If $\frac{1}{8}$ of a sheep be worth £$\frac{2}{5}$, and $\frac{3}{4}$ of a sheep be worth $\frac{1}{16}$ of an ox, what would be the cost of supplying a regiment with beef for 60 days, the average consumption being 2 oxen per day?

6. Find the equated time of payment of £120 due at present, £140 due 6 months hence, £200 due 3 months hence, and £500 due 4 months hence.

7. By selling tea at 4*s.* per lb., I gain 20 per cent.; what was the cost price, and what should I have gained or lost per cent. by selling at 2*s.* 8*d.* per lb.?

8. A house and garden cost £2480, the price of the house was to that of the garden as 5 to 3; find the price of each?

9. What is the cost per lb. of a mixture composed of 30 lbs. of tea, worth 4*s.* per lb., 60 lbs. worth 3*s.*, and 15 lbs. of inferior at 1*s.* per lb.; and how much per cwt. would have been gained by selling it at 3*s.* 4*d.* per lb.?

10. What is the net weight of 19 cwt. 3 qrs. 25½ lbs.; tare 18 lbs. per cwt., tret and cloff as usual?

PART II.

PAPER No. 30.

1. Express in figures ten millions two hundred and forty-five thousand three hundred and two.

2. Find L. C. M. of 12, 10, 6, and 24.

3. From 2136842 take 784021.

4. Express 4 by a fraction whose denominator is 7.

5. What number multiplied by 4 will produce 37240?

6. Reduce $\frac{3}{6}$, $\frac{3}{12}$, $\frac{4}{10}$ to equivalent fractions with L. C. D.

7. Reduce £23 to shillings and pence.

8. From 427·60215 take $68{\cdot}2\dot{3}$.

9. An oak which grows 4 inches every year is of the same height as an elm 30 years old, which has grown 12 inches every year; what is the age of the oak?

10. Multiply 7·214 by 4·001.

11. If 8 yds. of linen cost 24*s.*, what is the value of 22 yds.?

12. Divide 236·42 by ·2.

13. Six persons have to pay between them £820 2*s.* 6*d.*; what has each to pay?

14. Find by practice, the value of 2468 quarters of flour at £2 12*s.* 6*d.* per quarter.

15. A person spends £400 per annum; how much does he spend, on an average, a day?

PAPER No. 31.

1. What number divided by 24 will give 360 for a quotient?

2. From $2\frac{1}{2}$ take $1\frac{1}{4}$.

3. Find the value of 1420 yds. at 3*s.* 6*d.* per yd. (by multiplication).

4. Multiply $7\frac{1}{3}$ by $6\frac{3}{11}$.

5. Divide 120 mo. 2 w. 3d. 12 hrs. by 12.

6. Divide $4\frac{1}{9}$ by $\frac{4}{6}$.

7. In 50264 moidores, how many pieces of coin each 9*s.* ?

8. Add together 123·764, 5·02, and $6\cdot\dot{4}\dot{2}$.

9. If 2 cwt. of sugar cost £4 12*s.*, what must be paid for 5 cwt. 2 qrs. 14 lbs. ?

10. Multiply ·01 by ·234.

11. If 100 men do a piece of work in 12 days, how many can do it in 3 days ?

12. Divide 72·48 by ·012.

13. A banker received 200525 sovereigns; how long will he be counting them at 5 in one second ?

14. Bought 64 cwt. 1 qr. 17 lbs. of tea at 2*s.* $9\frac{1}{4}$*d.* per lb.; what did it cost.

15. A cow cost £12 and £5 for keeping; she gave £21 worth of milk, and was sold for £11. What was gained by her ?

PAPER No. 32.

1. What number added to 700 will equal the product of 320 and 450 ?

2. Find the G. C. M. of 234, 468, and 648.

3. Reduce 72015 hrs. to weeks.

4. Reduce $\frac{725}{26}$ to a mixed number.

5. What is the value of 100 plates at 4*d.* each ?

6. What fraction is 1*s.* 6*d.* of £2 ?

7. In 6358427 ounces how many tons ?

8. Multiply 426·5 by ·00021.

9. A man walked 40 miles in 18 hrs.; how many miles did he walk in 5 hrs. at the same rate ?

10. Divide 478·2 by 2·391.

11. A person bought 1763 yds. of cloth at 5*s.* $3\frac{1}{2}$*d.* per yd., and retailed it at 6*s.* 11*d.* per yd.; what was his profit ?

12. Reduce 3*s.* 6*d.* to the decimal of £1.

13. How many guineas are there in £42865 ?

14. A servant's wages are £16 a year; how much ought he to receive for 26 weeks ?

15. What number is to 7 as 6 is to 25 ?

PAPER No. 33.

1. Express in words 4203005621.

2. Reduce $\frac{4270}{38290}$ to its lowest terms.

3. Find the difference between the 10th part of 42030 and the 11th part of 78166.

4. Add together $4\frac{1}{2}$ and $\frac{3}{5}$ of $\frac{5}{9}$.

5. Reduce 4374720 inches to miles.

6. Find the value of $\frac{3}{8}$ of £1.

7. How much money would be required to pay 240 men each £10 3*s*. 6$\frac{1}{2}$*d*.?

8. Divide 4238 by ·2119.

9. If 10 horses can plough 45 acres in 12 days, in what time will 9 horses do the same?

10. Reduce 1 rd. 10 poles to the decimal of 1 acre.

11. A exchanges with B 40 yards of silk worth 8*s*. a yard for 25 yards of velvet; what was the price of the velvet a yard?

12. Reduce $\cdot 04\dot{1}\dot{6}$ to an equivalent vulgar fraction.

13. What is the value of 17 casks of currants, each weighing 1 cwt. 2 qrs. 3 lbs., if 2 cwt. 1 qr. 17 lbs. are worth £5 17*s*. 8*d*.?

14. Bought 21 parcels of cloth, each containing 38 yds. 1 qr. 3 nls., at 3*s*. 8$\frac{1}{4}$*d*. per yard, and sold them at 4*s*. 6$\frac{1}{2}$*d*. per yard; what was the amount of gain?

15. Find square root of 2025.

PAPER No. 34.

1. Express in figures one billion four hundred thousand three hundred, and two millions five hundred and three.

2. Reduce $7\frac{2}{3}$ to an improper fraction.

3. Square 42560.

4. Divide $\frac{1}{2}+2\frac{1}{3}$ by $\frac{1}{4}-\frac{1}{6}$.

5. Reduce 45 quarters to pints.

6. Reduce $\frac{2}{3}$*s*. to the fraction of £1.

7. If one bushel of malt cost 8*s*., what is the price of 4 quarters?

8. Divide 42·53 by 2·17.

9. How many square yards are there in a table 7 ft. long and 4 ft. broad?

10. Find value of ·2364 cwt.

11. How many coins, each worth 4*s.* 9*d.*, are there in £231 16*s.*?

12. If ·42 cwt. cost £1·2, what quantity can be bought for £5·62?

13. What number is to 5 as 6 is to 8?

14. Extract square root of 106929.

15. If 800 soldiers consume 5 sacks of flour in 6 days, how many will consume 15 sacks in 2 days?

PAPER No. 35.

1. What number divided by 60 will give 45 for a quotient, with a remainder 44?

2. Express 6 as a fraction with denominator 9.

3. Multiply £245 3*s.* 9*d.* by 248.

4. Reduce 4*s.* 2½*d.* to the fraction of £1.

5. Reduce 45 acres 3 rds. 2 poles to poles.

6. Find value of $\frac{3}{8}$ cwt.

7. How many revolutions will a wheel 8 ft. in circumference make in passing over a distance of 4 miles?

8. Divide 816 by ·0004.

9. What is the rent of a parish whose rate amounts to £4200 at 1*s.* 6*d.* in the £?

10. Reduce $\frac{3}{7}$ to a decimal.

11. If $6 : x :: 10 : 15$, find x.

12. Find the value of $\cdot 00\dot{1}3\dot{7}$.

13. If A can do a piece of work in 10 days, and B in 15 days, in what time would they do it if they both worked together?

14. Find simple interest on £485 10*s.* 6*d.* at 5 per cent. for 3½ years.

15. After taking from my purse ¼ of my money I find that $\frac{2}{3}$ of what is then left amounts to 7*s.* 6*d.*; what money had I in my purse at first?

PAPER No. 36.

1. Express in figures one hundred billions, one hundred and ninety-eight thousand six hundred millions ten thousand and ninety.

2. Multiply $2\frac{2}{3}$ by the difference between $4\frac{1}{9}$ and $3\frac{1}{6}$.

3. Reduce 4 fathoms to barleycorns.

4. From $8\frac{1}{4}$ take $6\frac{2}{5}$.

5. Multiply 2 cwt. 3 qrs. 5 lbs. by 234.

6. If $2\frac{2}{3}$ shares of a mine are worth £$40\frac{1}{2}$, what is the value of $5\frac{1}{3}$ shares?

7. If 5 cwt. of sugar cost £15, what would be the cost of 56 lbs.?

8. Multiply 2·001 by 34·2.

9. What is the value in English money of 1556·85 francs, when the exchange is at 24·25 francs per £?

10. Divide ·00005 by 2·5.

11. The wages of 5 men for 6 weeks being £14 5*s.*, how many weeks will 4 men work for £19?

12. A person sold ·12 of an estate to one person, and $\frac{3}{5}$ to another; what part of the whole did he still retain?

13. How many revolutions will the wheel of a waggon, whose circumference is 4 yds., make in going a distance of 5 miles 4 yds.?

14. If 10 horses or 16 oxen can perform a piece of work in 12 days, what time would 4 horses and 8 oxen be doing it?

15. Extract the square root of 54289.

PAPER No. 37.

1. Express in figures five hundred and nine millions six thousand and one.

2. From $\frac{11}{14} \times \frac{9}{112}$ take $\frac{41}{56}$.

3. Divide 7890567 by 42, first by long division, and secondly by its factors six and seven.

4. Divide $5\frac{1}{3}$ of $4\frac{1}{8}$ by $7\frac{1}{3}$.

5. If a land-mile consists of 1760 yards, and a knot, or sea-mile of 6080 feet, how many knots correspond to 1400 land-miles?

6. Reduce 14*s.* $10\frac{1}{2}$*d.* to the fraction of a pound.

7. Divide 121260 cubic yards, 22 cubic feet, 392 cubic inches, by 584.

8. Multiply ·1 by ·1, and divide the product by ·0054.

9. Required the value of 17 pieces of cloth, each 43 yds. 2 qrs., at £1 8*s.* 0½*d.*, for 2 yds. 3 qrs.

10. Reduce $\frac{321}{625}$ to a decimal.

11. A coach wheel, 7 ft. 8 in. in circumference, revolves 3762 times in performing a certain journey, what would be the circumference of a wheel which made only 3496 revolutions in the same distance?

12. Find the sum of ·125 of 30*s.*, and ·375 of 13*s.* 4*d.*

13. Standard gold being worth £3 17*s.* 10½*d.* per oz. troy, what will be the price of 2 lbs. 9 oz. 6 dwts. 16 grs.?

14. If ten men can reap a field of corn of 7½ acres in 3 days of 12 hours each, how long will it take 8 men to reap 9 acres, working 16 hours a day?

15. A can perform a work in 4 days which B can perform in 5; in what time can they perform it together?

PAPER No. 38.

1. The moon's distance from the earth is two hundred and forty thousand miles, and the sun's is ninety-five millions of miles; how much is the sun further from the earth than the moon?

2. Reduce to its lowest terms $\frac{6409}{7395}$.

3. Reduce 540697 inches to miles, furlongs, &c.

4. From $10\frac{2}{21}$ take $7\frac{5}{14}$.

5. Multiply 15 lbs. 9 oz. 17 dwt. 13 grs. by 23.

6. Multiply together $\frac{5}{6}$, $\frac{9}{10}$, and $2\frac{1}{3}$.

7. If 4 cwt. 1 qr. 26 lbs. of tobacco cost £43 18*s.* 6*d.*, what quantity can be purchased for £4 19*s.* 9*d.*?

8. Multiply 7·51 by ·0016.

9. What quantity of silver can be bought for £36 when 14 lbs. 6 oz. 15 dwts. cost £45?

10. Divide 201·4095 by ·703.

11. A person's income is £592 10*s.*, his weekly expenses are £7 10*s.*, and he gives away £20 annually in charity; how much will he have remaining?

12. Reduce $100\frac{4}{125}$ to a decimal.

13. When coals cost 11*s.* 6*d.* a ton, what will be the *annual* expense of fuel for an engine whose daily consumption averages $2\frac{1}{2}$ tons?

14. How many days of 15 hours each would 60 men take to perform a piece of work in, when 45 men can do it in 30 days of 12 hours each?

15. If 1 lb. troy of gold be coined into £46 14*s.* 6*d.*, what is the weight of a sovereign?

PAPER No. 39.

1. What number divided by 9612 gives for a quotient 58647?

2. Add together $\frac{3}{7}$, $\frac{5}{21}$, and $\frac{17}{24}$.

3. A gold watch and chain cost £20, the watch being £11 10*s.* dearer than the chain: find the price of each article.

4. Multiply ·0625 by 1·74.

5. If A have £3 3*s.* $3\frac{3}{4}$*d.* in his pocket, and B have £2 0*s.* $10\frac{1}{4}$*d.*; how many farthings have they between them, and how much money must A give to B that the latter may have 2000 farthings?

6. What is the value of $2\frac{2}{7}$ of £6 3*s.* 4*d.*?

7. A farmer buys 15 sheep at £1 11*s.* 4*d.* each; three of them having died, at what price did he sell the rest to gain 38*s.* by the bargain?

8. Divide $5\frac{5}{14}$ by $12\frac{1}{2}$.

9. What is the weight in pounds, of ten anchors, which weigh altogether 46 tons 1 qr. 17 lbs.?

10. Add together 14·1254, 11·5, 161·0004, and 17·112.

11. Required the amount of 25 cwt. of tobacco at £7 15*s.* 8*d.* per cwt.

12. Reduce $\frac{1}{128}$ to a decimal.

13. What quantity of silver may be bought for £72, if the cost of 14 lbs. 6 ozs. 15 dwts. be £45?

14. Find the cost of 2 qrs. 24 lbs. at the rate of 20 guineas a ton.

15. If the carriage of 6 cwt. 2 qrs. for 124 miles cost £3 4*s.* 8*d.*, what weight will be carried 93 miles for £3 0*s.* $7\frac{1}{2}$*d.*?

PAPER No. 40.

1. Reduce 13072045 sq. inches to acres.

2. Multiply 8 mls. 3 fur. 20 pls. 3 ft. 8 in. by 72.

3. Simplify $\frac{3}{4}$ of $\frac{2}{3}$ of $\frac{3}{5} - \frac{1}{2}$ of $\frac{2}{3}$ of $\frac{7}{10}$.

4. In a bag containing £24 7*s*. 6*d*. there are an equal number of half-crowns, crowns, half-sovereigns, and florins; how many are there of each?

5. Reduce 13*s*. 7½*d*. to the fraction of £5 10*s*.

6. If 5 men can do a piece of work in 27 days, how long would 6 men take to do double the quantity at the same rate?

7. If $\frac{2}{7}$ of a ship is sold for £1250, what is the value of the whole?

8. A straight plank is 4½ in. thick and 9 in. broad; how much must be cut off, so that it may contain 8½ cubic feet of timber?

9. What is the value of 137 articles at £1 17*s*. 6¼*d*. each?

10. Reduce $\cdot 024\dot{6}\dot{9}$ to its equivalent vulgar fraction.

11. A can do a piece of work in 6 days which B can do in 4 and C in 3. How soon would they do it working together?

12. Reduce 1 cwt. 2 qrs. 3 lbs. to the decimal of 1 ton.

13. How many bricks are there in a wall 100 yds. long, 2 yds. high and 13 inches thick? allowing for a doorway 4 ft. wide and 6 ft. high, the content of a brick being 108 cubic inches.

14. Find the value of ·35 ton + ·025 cwt. + ·275 lbs.

15. Three persons having £$4\frac{7}{12}$, £$5\frac{9}{32}$, and £$2\frac{5}{6}$, respectively subscribe $\frac{2}{11}$, $\frac{2}{13}$, and $\frac{1}{8}$ of their money; what is their total subscription?

PAPER No. 41.

1. A person bought 123 shares in a railway, for each of which he gave £27 16*s*. 8*d*.; he afterwards sold 67 of them at £36 15*s*. 7*d*. each. How much more money did he want to make up his original outlay?

2. Find the least common multiple of 28, 8, 40, 50, 25, and 65.

3. Divide £3676 13*s*. 10$\frac{1}{4}$*d*. by 275.

4. From $\frac{7}{6}$ take six-sevenths.

5. Divide 3587 yards 9 in. into 27 equal distances.

6. What is the difference between one-fifteenth of a pound and one-fourteenth of a guinea?

7. How many guineas are there in nine hundred and ninety-nine pounds?

8. Find the vulgar fraction in its lowest terms, corresponding to ·00625.

9. How many pounds of copper are there in a million of pence, each weighing an ounce? and what is the value of the sum?

10. Divide 46·44 by ·0336.

11. To how many persons may £60 15*s*. 6*d*. be distributed, giving to each person £4 13*s*. 6*d*.?

12. Find the sum of ·175 of a ton, ·195 of a cwt., and ·145 of a quarter.

13. Extract the square root of 54804409.

14. If the velocity of sound be 1142 feet in a second, in what time will the report of a gun be heard at the distance of 13 miles?

15. A person buys 2 cwt. 17$\frac{1}{2}$ lbs. of a certain article, for which he pays £5 per cwt.; but, in consequence of its being damaged, the price is afterwards reduced to 8*d*. per lb.; how much money will be returned to him?

PAPER No. 42.

1. A grocer received three boxes of oranges: in one there were thirty-three dozen; in another, thirty-five dozen and ten, and in a third, thirty-seven dozen and five. How many oranges were there in all?

2. Add together $\frac{3}{14}$, $\frac{6}{7}$, $\frac{5}{28}$, and $\frac{7}{12}$.

3. What would a peal of eight bells cost, if each bell cost £52 6*s*. 8*d*., and the fixing of the whole set £31 6*s*. 8*d*. more?

4. Multiply together 5$\frac{1}{4}$, 3$\frac{3}{4}$, and $\frac{4}{21}$.

5. Multiply £99 19*s.* 11$\frac{3}{4}$*d.* by 144.

6. Divide 11$\frac{2}{3}$ by 6$\frac{3}{7}$.

7. If 1000 sovereigns weigh 21 lbs. 5 ozs. 16 dwts. 6 grs., what is the weight of one sovereign?

8. Add together 16·5, 176·11, 11·0012, and 18·752.

9. 'The United States' dollar is worth 4*s.* 1*d.*: what is the value of the President's salary, which is 25,000 dollars?

10. Divide ·00456 by ·1458.

11. Find the cost of 6 tons of iron, at 9*s.* 4$\frac{1}{2}$*d.* for 1 cwt. 1 qr.

12. Reduce 11*s.* 2$\frac{1}{4}$*d.* to the decimal of a pound.

13. If a labourer earn 1*s.* 9*d.* a day when wheat is at 7*s.* a bushel, what ought he to receive when wheat is at 9*s.* a bushel?

14. A grocer bought 14 lbs. of sugar for 6*s.* 3*d.*, and sold it at 5$\frac{3}{4}$*d.* per lb.; how much per cent. did he gain?

15. Extract the square root of 90368789.

PAPER No. 43.

1. Add together 723 tons 14 cwt. 2 qrs. 15 lbs.; 24 tons 8 cwt. 1 qr. 23 lbs.; 584 tons 17 cwt. 3 qrs. 8 lbs.; 1 cwt. 27 lbs.; 15 tons 3 qrs.

2. Find the greatest common measure of 330 and 10021.

3. Multiply £1008 9*s.* 2$\frac{3}{4}$*d.* by 1803.

4. From the sum of $\frac{1}{4}$ and $\frac{5}{12}$ take $\frac{7}{24}$.

5. Divide 6948 yrs. 6 mths. 3 wks. 6 dys. 14 hrs. by 675.

6. Multiply 5$\frac{1}{3}$ by 4$\frac{1}{8}$.

7. How many pounds are there in 3 cwt. 3 qrs. 27 lbs.? Also how many parcels, each 10 lbs. 4 oz., can be made up from the same weight?

8. From 165·1165 take 13·00785.

9. In £714 17*s.* 5$\frac{3}{4}$*d.*, how many crowns, half-crowns, and three-penny pieces are there?

10. Multiply ·03162 by ·00146.

11. How many farthings are there in three sovereigns, three half-sovereigns, and three half-crowns?

12. Divide 250 by ·000035.

13. How much gold dust can be purchased for £1073 9*s*. 6*d*., at £3 5*s*. per ounce?

14. What must be given for 10 pieces of cloth, each containing 12 yds. 2 qrs., at 8*s*. 6*d*. a yard?

15. If the carriage of 3 cwt. 1 qr. 18 lbs. of goods comes to £1 18*s*. 5¼*d*., what will be charged for carrying a ton the same distance?

PAPER No. 44.

1. What number is contained exactly 39 times in 2325843?

2. Find the least common multiple of 363, 484, and 605.

3. How much cloth is in 54 pieces, each containing 23 yds. 1 qr. 3 nls.?

4. From $\frac{5}{9}+\frac{3}{5}$ take $\frac{7}{18}$.

5. If a man's weekly wages be £1 6*s*. 4*d*., how much more does he make in a year than another man who earns 19*s*. 9*d*. weekly?

6. Reduce 6 yds. 2 ft. to the fraction of a mile.

7. A carriage load is found to weigh 2 tons 6 cwt. 2 qrs., and it consists of 215 equal packages; what is the weight of each package in pounds?

8. From 67·575 take 3·215495.

9. What quantity of land is worth £1430, if the value of 32 ac. 1 rd. 36 pls. be £1560?

10. Divide 49·7 by ·0025.

11. A bankrupt owes his creditors £2960, and can pay them 12*s*. 6*d*. per £. How much would a person receive to whom he owes £641 18*s*. 4*d*.?

12. Find the sum of ·035 of £5, and ·001625 of £10 6*s*. 8*d*.

13. A garrison of 636 men have provisions for a year (365 days); how long will these provisions last, at the same rate per man, if the garrison is increased to 1460 men?

14. If an article be bought for 17*s*. 6*d*., and sold for 18*s*. 4½*d*., what is the gain per cent.?

15. What must be paid for the work of 36 men for 7 months, when the wages of 50 men for 12 months amount to £1080?

PAPER No. 45.

1. Divide five hundred times 99383 by twenty-three times 596.

2. From the sums of $\frac{3}{4}$ and $\frac{7}{9}$ take $1\frac{5}{12}$.

3. How many grains are there in 21 lbs. 3 oz. Troy?

4. Reduce to a simple fraction $1\frac{1}{5}$ of $\frac{5}{4}$ of $\frac{3}{2}$ of $\frac{8}{5}$ of $\frac{4}{3}$.

5. Divide 25808 cwt. 2 qrs. 2 lbs. 14 oz, by 338.

6. How many pounds are there in $18\frac{1}{2}$ packages, each weighing on an average $115\frac{3}{4}$ lbs.?

7. Add together ·005, ·0027, 21·005, 30·0486, and 74·0637.

8. Find the circumference of a wheel making 16160 revolutions in $2\frac{1}{2}$ miles.

9. Divide ·00071012 by 1·732.

10. If a piece of plate that weighs 7 oz. 9 dwts. 15 grs. cost £11 12*s.* 2*d.*, how much of it costs £1 13*s.* 2*d.*?

11. Reduce 6 cwt. 2 qrs. 7 lbs. to the decimal of a ton.

12. An income tax of 7*d.* in the pound is paid by 800,000 persons, and realises the sum of £5,000,000; what is the average income of each person?

13. Find the amount of £267 16*s.* for $3\frac{1}{2}$ years, at $4\frac{1}{2}$ per cent., simple interest.

14. If a tradesman buys cloth at 13*s.* $4\frac{1}{2}$*d.* per yard and sells it at 14*s.* 9*d.* per yard. what is his gain per cent.?

15. If the carriage of 60 cwt. for 20 miles cost £3 12*s.* 6*d.*, what weight can be carried 30 miles for £5 8*s.* 9*d.*?

PAPER No. 46.

1. A workman's earnings in seven successive weeks were, respectively, 17*s.* 6*d.*, 18*s.* 6*d.*, 18*s.* 10*d.*, 16*s.* 7*d.*, 14*s.*, 16*s.* 11*d.*, and 17*s.* 5*d.*; required the whole amount.

2. Add together $\frac{3}{4}$, $\frac{5}{8}$, $\frac{7}{24}$, and $\frac{9}{120}$.

3. Multiply £26 6*s.* $10\frac{1}{4}$*d.* by 969.

4. Multiply together $\frac{2}{3}$, $3\frac{1}{2}$, $4\frac{1}{10}$, and $\frac{3}{82}$.

5. How much is the 10th part of 12 weeks' wages, at £2 15*s.* $2\frac{1}{2}$*d.* a week?

6. Divide $23\frac{7}{15}$ by $5\frac{1}{3}$.

7. Add together 264 oz., 264 lbs., 264 cwt., and 264 tons.

8. Multiply 23·046 by ·0036.

9. Bought 13 cwt. 1 qr. 8 lbs. of tea at £1 11*s.* 9*d.* per qr. ? what does the whole cost ?

10. Divide 1·48877 by 28·09.

11. If a workman earns £34 12*s.* in 205 days, how long will he be earning 50 guineas ?

12. Extract the square root of 575·25 to two places of decimals.

13. Standard gold being worth £3 17*s.* 10½*d.* per oz. troy, what would be the price of 2 lbs. 2 oz. 6 dwts. 16 grs. ?

14. If I buy 14 sheep for £39 6*s.* 5½*d.* and sell six of them for 36*s.* each, what must I sell the remainder for, so that I may neither gain nor lose ?

15. Find what £325 10*s.* will amount to in four years, at 5½ per cent. simple interest.

PAPER No. 47.

1. What number divided by 1472 will give 3743034 for a quotient, and 49 for a remainder ?

2. Find the value of $\frac{5}{6}-\frac{3}{4}+\frac{2}{3}-\frac{1}{2}$.

3. How many farthings are there in 4 guineas, 5 half-guineas, 6 crowns, and 7 half-crowns ?

4. Divide $2\frac{7}{8}$ by $\frac{3}{5}$ of $4\frac{1}{3}$.

5. Prize money to the amount of £103368 16*s.* 10½*d.* is to be divided among 5793 men, after reserving £7000 for the officers ; what will be each man's share ?

6. A person who was possessed of $\frac{3}{5}$ of a copper mine sold $\frac{3}{4}$ of his share for £2280 ; what was the value of the whole mine at that rate ?

7. Multiply 17 weeks 6 days 6 hours 42 minutes by 113.

8. Multiply 32·56 by ·00457.

9. A man buys 25 sheep for £36, and 30 more for £46 ; what will he gain or lose by selling them at £1 10*s.* 6*d.* a piece ?

10. Reduce 3·35 shillings to the decimal of £1.

11. If 2 qrs. 16 lbs. cost 19*s.* 6*d.*, what will 18 parcels cost, each weighing 3 qrs. 18 lbs.?

12. From £16·275 take 12·375 guineas.

13. Extract the square root of 172265625.

14. A man who works 10 hours a day does a piece of work in 9 days; how many hours a day must he work to finish it in 8 days?

15. If 48 guns consume in 3 days 288 barrels of powder, how much will be spent in 15 days, when 144 guns are to be supplied?

PAPER No. 48.

1. From ninety thousand nine hundred and nine, subtract nine thousand and ninety-nine.

2. Express as a simple fraction $\frac{3}{7}$ of $2\frac{1}{9}$ of $2\frac{4}{19}$.

3. How often is £24 11*s.* contained in £8060 18*s.* 10*d.*?

4. Multiply together $2\frac{1}{5}$, $3\frac{1}{3}$, and $\frac{15}{19}$.

5. Multiply 5 tons 3 cwt. 1 qr. 10 lbs. by 168.

6. What fraction of 15*s.* $7\frac{1}{4}$*d.* is 2*s.* $3\frac{1}{4}$*d.*?

7. Four persons were to receive 150 guineas; the first was to receive £57 19*s.* 7*d.*, and the rest was to be equally divided among the other three; how much did each receive?

8. Divide ·129 by ·0003.

9. What is the tax upon £302 3*s.* 7*d.*, when £429 8*s.* 3*d.* is rated at £6 1*s.* 6*d.*?

10. Extract the square root of $\frac{3}{5}$.

11. How much money will pay for 18 qrs. of wheat at £2 15*s.* $6\frac{1}{4}$*d.* per quarter, and 54 qrs. of oats at £1 18*s.* $3\frac{1}{2}$*d.* per quarter?

12. Reduce 5*s.* to the decimal of 13*s.* 4*d.*

13. If £731 15*s.* be the rent for 365 ac. 3 rds. 20 pls., what is the rent of 100 acres?

14. If 2 cwt. 1 qr. 18 lbs. of tea cost as much as 18 cwt. 9 lbs. of sugar, how much sugar should be given in exchange for 1 lb. of tea?

15. What is the amount on £845 17*s.* 10*d.* for 5 years, at 3 per cent., simple interest?

PAPER No. 49.

1. Multiply ten millions thirty-eight thousand and forty-eight, by one million fifteen thousand; and divide the product by one hundred and twenty-six thousand eight hundred and seventy-five.

2. Divide $5\frac{5}{14}$ by $12\frac{1}{2}$.

3. How many days, hours, minutes, and seconds are there in 1178825 seconds?

4. Add together $2\frac{1}{3}$, $4\frac{1}{5}$, and $5\frac{1}{4}$.

5. Divide 2959 lbs. 2 oz. 12 dwts. 10 grs. by 606.

6. Required the sum of $\frac{5}{8}$ of £2 10*s.* and $\frac{3}{7}$ of £8 4*s.* 6*d.*

7. If 4 cwt. 1 qr. 26 lbs. of tobacco cost £43 18*s.* 6*d.*, what quantity can be purchased for £4 19*s.* 9*d.*?

8. Divide ·3456 by ·0054.

9. If 5 yards of cloth cost 14*s.* 2*d.*, what must be given for 9 pieces, each measuring 21 yds. 1 qr.?

10. Express as a vulgar fraction ·0016.

11. If £433 7*s.* be paid in crowns, half-crowns, shillings, and sixpences, in equal numbers, how many coins of each species will there be?

12. Reduce 1·075 lb. to the decimal of a cwt.

13. If the carriage of 15 tons 17 cwt. 1 qr. of goods for 257 miles 6 furlongs cost £16 6*s.* $7\frac{1}{4}$*d.*, what weight at the same rate will be carried 211 miles 4 furlongs for £21 15*s.* 6*d.*?

14. What is the simple interest of £172 17*s.* 6*d.* for 5 years, at 4 per cent. per annum?

15. Extract the square root of 903687890625.

PAPER No. 50.

1. How many feet are there in 5 miles 3 fur. 4 pls. 3 yds.?

2. Reduce to a simple fraction $39\frac{1}{6}$ of $\frac{9}{47}$.

3. Reduce 15 lbs. 10 oz. 14 grs. troy to grains.

4. Reduce to its simplest form $\frac{1}{7}+\frac{3}{11}+\frac{17}{13}-\frac{581}{1001}$.

5. Find the price of 60 lbs. 8 oz. of gold, at £3 10*s.* $11\frac{1}{4}$*d.* per ounce.

6. Find the value of $\frac{8}{27}$ of 2 tons 6 cwt. 0 qr. 18 lbs.

7. If an ounce of gold be worth 4 guineas, what is the value of a grain?

8. Divide 313·24 by 24997·5.

9. What is the price per yard of cloth which costs £6656, if it consists of 32 parcels, and each parcel contains 10 pieces, and each piece 26 yards?

10. Express 7*s.* 10$\frac{1}{2}$*d.* as the decimal of a guinea.

11. What is the simple interest of £172 17*s.* 6*d.* for 5 years, at 4 per cent. per annum?

12. Extract the square root of 7·00321.

13. If 780 men on full rations consume 221 quarters of wheat in 119 days, how many on half rations will consume 437 quarters in 57 days?

14. What quantity of material that is $\frac{3}{4}$ of a yard wide will line 9$\frac{1}{2}$ yards of cloth that is 2$\frac{1}{2}$ yards wide?

15. If 20 men can reap a field of 7$\frac{1}{2}$ acres in 1$\frac{1}{2}$ days of 12 hours each, how long will it take 8 men to reap 9 acres, working 16 hours a day?

PAPER No. 51.

1. Multiply the difference between 310342 and 291264 by 5409.

2. Find the least number which can be divided by each of the numbers 849 and 1132.

3. Add together 165 guineas, 76 half-crowns, and 165 pence.

4. Add together $\frac{1}{2}$, $\frac{2}{3}$, 3$\frac{1}{2}$, and 5$\frac{1}{6}$.

5. A man whose weekly earnings are 18*s.* 9*d.* saves $\frac{1}{6}$th part every three weeks. In what time will he gain £150?

6. If 4$\frac{5}{9}$ oz. of tea cost 1$\frac{2}{5}$*s.* what will 1 cwt. 1 qr. 14$\frac{4}{7}$ lbs. cost?

7. If a boy can buy 100 oranges for 9*s.* 6$\frac{1}{2}$*d.*, what must he pay for two and a half dozen?

8. Multiply ·007 by ·762.

9. What must be given for four casks of currants, each weighing 6 cwt. 1 qr. 17 lbs. at £2 17*s.* 8*d.* per cwt.

10. Reduce 7*s.* $4\frac{1}{2}$*d.* to the decimal of a £.

11. How many steps of 2 ft. 7 in. each must a person take in a minute to walk at the rate of 4 miles an hour?

12. If 4·47 oz. of tea cost 1·48*s.*, what will 1·175 cwt. cost?

13. If two men in a tour of three months spend £140, how much at the same rate would it cost a party of 5 persons travelling 11 months?

14. Extract the square root of 22071204.

15. If 3 cwt. of tea cost 40 guineas, and it be retailed so as to gain £5 14*s.* on the whole, what is the selling price per pound?

PAPER No. 52.

1. Multiply the difference between 50436 and 49128 by the difference between 12173 and 11846.

2. Express as a simple fraction $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{2}{5}$ of $\frac{5}{7}$ of $\frac{16}{9}$.

3. Multiply 21 cwt. 3 qrs. 19 lbs. by 217.

4. Find the value of $\frac{5}{6}$ of £2 15*s.* 8*d.*

5. At what rate per hour does a place at the equator move, if the circumference of the earth be 25,000 miles, and the earth turns on its axis once in 24 hours?

6. If $3\frac{5}{9}$ oz. avoirdupois cost $3\frac{1}{2}$ shillings, what is the value of $10\frac{1}{7}$ lbs.?

7. Find the weight in lbs. of 3 dozen table-spoons, each weighing 2 oz. 3 dwts.

8. Find the quotient of ·10724 divided by ·003125.

9. If the carriage of 5 cwt. 0 qr. 7 lbs. for 84 miles cost £3 18*s.* 4*d.*, what will it cost to have 21 cwt. 1 qr. 14 lbs. carried the same distance?

10. Express ·00875 as a vulgar fraction in its lowest terms.

11. If 2 gallons of spirits be sold at 18*s.* 6*d.* per gallon, 3 gallons at 19*s.* 10*d.*, and 5 at £1, what is the average value per gallon?

12. If the price of a lb. of sugar be ·5625 of 2*s.*, what is the value of ·75 of a cwt.?

13. By selling goods at $8\frac{1}{4}$*d.* per lb. which had been

bought at 4 guineas per cwt., I lost £85; what quantity did I sell?

14. Extract the square root of 43046721.

15. If 48 men can perform a piece of work in 16 days of 9 hours each, in how many days of 12 hours each can 64 men accomplish the same?

PAPER No. 53.

1. What number multiplied by 265 will give 1490097385 for the product?

2. Add together $1\frac{7}{16}$, $\frac{5}{8}$, and $31\frac{1}{2}$.

3. How many farthings are there in 6 sovereigns, 6 half-sovereigns, and 6 half-crowns?

4. Divide $\frac{1}{2}$ of $\frac{2}{3}$ by $\frac{2}{3}$ of $\frac{3}{4}$.

5. Multiply £763 13*s.* $7\frac{3}{4}$*d.* by 875.

6. What is the sum of $\frac{4}{7}$ of a cwt., $8\frac{5}{8}$ lbs., and $3\frac{9}{10}$ ozs.?

7. How many revolutions will the wheel of a carriage 4 ft. 7 in. in circumference make in 2 miles 4 furlongs?

8. Add together 303·303, 172·172, ·0606, 23, and 27·4274.

9. A carriage load is found to weigh 1 ton 3 cwt. 1 qr., and it consists of 215 equal packages; what is the weight of each?

10. Divide 4·8 by ·00016.

11. If £72 10*s.* $7\frac{1}{2}$*d.* can purchase 5 pieces of cloth, each containing 33 yards, how many pieces of the same length can be bought for £57 10*s.*?

12. Reduce 7 oz. 4 dwts. to the decimal of a pound troy.

13. Extract the square root of 38950081.

14. A house and garden cost £850, and the price of the house was to that of the garden as 11 : 5; find the price of of each.

15. A housekeeper with £12 has to pay for 4 cwt. 3 qrs. 26 lbs. of sugar, at 2 guineas a cwt., and is to spend the rest in coffee at 1*s.* 3*d.* per lb.; how much coffee does he buy?

PAPER No. 54.

1. What number divided by 237 gives for a quotient 2374?

2. Find the least common multiple of 2, 4, 6, 8, 10.

3. The yearly subscriptions to a hospital amount to £2146 17*s.* 4*d.*, and the average cost of each patient is £9 1*s.* 8*d.*; how many will it maintain?

4. From $7\frac{4}{9}$ take $3\frac{7}{9}$.

5. Find the number of days, &c., in the solar year, consisting of 31556928 seconds.

6. If $\frac{2}{3}$ of an estate be worth £$1649\frac{3}{11}$, what is the value of $\frac{3}{4}$ of $7\frac{1}{9}$ of the same?

7. Reduce 1384685 inches to furlongs.

8. Add together 31416, 3141·6, 314·16, and 31·416.

9. If a shot were to go round the earth at the same rate it left the gun (1260 feet a second), in what time would it return to the place from which it was fired, supposing the circumference of the earth to be 25,000 miles?

10. Divide 7·418 by ·7418.

11. A portion of a bankrupt's goods having been bought at £1 16*s.* 7*d.* per cwt., were sold at a loss of 25 per cent.; what was the selling price per cwt.?

12. If 3*s.* $4\frac{1}{2}$*d.* be given for $6\frac{3}{8}$ lbs., what must be given for 1·274 cwt.?

13. Find the value of 17 cwt. 3 qrs. 17 lbs. at 4*s.* $6\frac{1}{2}$*d.* for 15 lbs.?

14. What must be given for 8 pieces of cloth, each containing 36 yds. 1 qr. 3 nls., at 3*s.* 7*d.* per yard?

15. If 12 cwt. 1 qr. 10 lbs. cost £7 14*s.* 9*d.*, how much can be bought for 150 guineas?

PAPER No. 55.

1. Multiply 2 tons 13 cwt. 2 qrs. by 198.

2. Find the sum of $\frac{1}{2}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{7}{8}$.

3. Divide 25584 tons 0 cwt. 1 qr. 2 lbs. by 74.

4. Which is the greater, $\frac{3}{5}$ or $\frac{5}{7}$? and how much?

5. If a coal waggon can convey 2 tons 13 cwt. 26 lbs., how many waggons will be required to convey coal sufficient for a steamer whose stowage is 298 tons 2 cwt.?

6. Reduce £7 13*s.* $1\frac{1}{2}$*d.* to the fraction of £2 6*s.* $10\frac{1}{2}$*d.*

7. A person's salary is £191 12*s.* 6*d.* per annum; what ought he to receive for 60 days' service?

8. Reduce $\frac{169}{900}$ to a decimal.

9. Find the price of 3 cwt. 2 qrs. 10 lbs. at 12*s.* $4\frac{3}{4}$*d.* for $3\frac{1}{2}$ lbs.

10. Multiply $\frac{3}{5}$ by ·014.

11. A person whose debts amount to £1500 pays £950; how much is that in the pound?

12. Divide £·12 by ·000625.

13. A, B, and C had shares in a prize in the proportion of 3, 5, and 7; the prize was worth £1000: what did each receive?

14. Extract the square root of 66455104.

15. A person with £12 has to pay for 4 cwt. 3 qrs. 26 lbs. of sugar at 2 guineas a cwt., and is to spend the rest in coffee at 1*s.* 3*d.* per lb.; how much does he buy?

PAPER No. 56.

1. If a person's annual income be £417 16*s.* 10*d.*, what is his income per day?

2. Find the value of £$\frac{1}{7}$ + $\frac{2}{9}$*s.* + $\frac{5}{12}$*d.*

3. Multiply £17 14*s.* $8\frac{1}{2}$*d.* by $23\frac{3}{4}$*d.*

4. What fraction of a pound is $\frac{3}{14}$ of a penny?

5. A land mile is 1760 yards, and a knot is 6080 feet; how many knots are there in 1400 land miles?

6. Express as a simple fraction $\dfrac{\frac{5}{8} \text{ of } \frac{4}{10} - \frac{7}{9} \text{ of } \frac{4}{21}}{\frac{5}{6} \text{ of } \frac{2}{15} - \frac{3}{8} \text{ of } \frac{4}{18}}$.

7. If 3 oz. 9 dwts. cost 6*s.* 11*d.*, what must be given for 10 lbs. 2 oz. 3 dwts.?

8. Multiply 20·102 by ·0034.

9. A bankrupt owes £360 16*s.* 3*d.*, and his effects are worth only £240 15*s.* 6*d.*; how much will his creditors receive in the pound?

10. Reduce ·00875 to a vulgar fraction in its lowest term.

11. If a wheel whose circumference is 5 yds. 1 ft. 6 in. makes 64640 revolutions, what space will it pass over?

12. Express as a vulgar fraction the circulating decimal $\cdot 01\dot{3}4\dot{2}$.

13. If a single article can be bought for 3*s.* 7*d.*, how many dozens can be bought for £86 10*s.*?

14. What is the amount of £320 15*s.* for 2 years at $4\frac{1}{2}$ per cent., simple interest?

15. A person can perform a journey in 13 days 8 hours when he travels 12 hours 45 minutes a day; how long will he be performing it when he travels 10 hours 12 minutes a day?

PAPER No. 57.

1. Divide £437 16*s.* $8\frac{1}{2}$*d.* by 99.

2. Express as a single fraction $2\frac{1}{2}$ of $\frac{4}{5}$ of $7\frac{1}{8}$.

3. Multiply 14 hrs. 17 m. 18 sec. by 108.

4. Reduce $\frac{1728}{6144}$ to its lowest terms.

5. Multiply 16 lbs. 7 oz. 12 drs. by 126.

6. If $14\frac{7}{8}$ lbs. cost 6*s.* $4\frac{3}{4}$*d.*, what is the worth of $\frac{3}{5}$ of a cask weighing $\frac{2}{3}$ of a ton?

7. Reduce 15 cwt. 18 lbs. 3 oz. to ounces.

8. From 23·0001 take 2·301.

9. In £14785, how many guineas and half-crowns?

10. Multiply and divide 1·005 by ·005.

11. How many weeks are there in one million seconds?

12. If a pound of sugar cost ·008 of £$2\frac{4}{5}$, what is the value of $3\frac{1}{4}$ cwt.?

13. If 13 tons 2 cwt. of goods cost £217 13*s.* 8*d.*, what must be given for 3 tons 12 cwt.?

14. The circumference of a wheel is 15 ft. 3 in.; how often will it turn round in a distance of 81 miles?

15. What is the value of 17 parcels of cloth, each measuring 13 yds. 1 qr. 3 ells, at 6*s.* $7\frac{1}{2}$*d.* per yard?

PAPER No. 58.

1. From fourteen million two hundred and seven thousand and three take 1490002.

2. From the sum of $\frac{2}{3}$ and $\frac{17}{24}$ take $\frac{11}{42}$.

3. What is the value of three grains of gold at £4 an ounce?

4. Divide $11\frac{2}{3}$ by $6\frac{3}{7}$.

5. How many yards of lace at 1*s.* $8\frac{1}{2}$*d.* per yard can be purchased with 19 guineas?

6. Reduce £2 17*s.* $7\frac{1}{5}$*d.* to the fraction of £3 12*s.*

7. What will a service of plate be worth which weighs 1 lb. 10 oz. 10 dwts. 4 grs., if the value of an ounce be 5*s*. 6*d*.?

8. Divide ·04149 by ·342.

9. If the carriage of 6 cwt. 2 qrs. 14 lbs. cost £2 19*s*. 6*d*., what should be paid for 1 ton 19 cwt. 3 qrs. at the same rate?

10. Reduce $\frac{321}{625}$ to a decimal.

11. From 3 tons 5 cwt. take 1 ton 16 cwt. 3 qrs. 12 oz.; and find the value of the remainder at £1 7*s*. 6*d*. for 1 qr. 27 lbs.

12. Find the value of ·1875 of a cwt.

13. Extract the square root of 144024001.

14. If a certain sum pay for the carriage of 800 lbs. for 120 miles, how far ought 448 lbs. to be carried for the same money?

15. If 45 men can do a piece of work in 30 days of 12 hours each, how many days of 15 hours each would it take 60 men to perform the same work?

PAPER No. 59.

1. Write down in words the following numbers: 987654321, 98765432·1.

2. Find the least common multiple of 120, 140, 168, 210.

3. If the dividend be 21810149152, and the quotient be 39314, what is the divisor?

4. Reduce to a simple fraction $\frac{4}{5}$ of $\frac{19}{17}$ of $\frac{4}{9} \times \frac{5}{4}$ of $\frac{7}{9}$.

5. Subtract 2006 tons 17 cwt. 2 qrs. 24 lbs. 13 ozs. 13 drs. from 3884 tons 3 cwt. 3 qrs. 17 lbs. 15 ozs. 11 drs.

6. Find the value of $\frac{1}{9}$ of $\frac{3}{10}$ of £1 $-\frac{7}{9}$ of $4\frac{1}{2}d+\frac{8}{15}$ of 2*s*. 6*d*.

7. If 120 men receive £59 17*s*. $8\frac{3}{4}d$. each as prize money, what is the whole amount?

8. Multiply 21·32 by ·100406.

9. In 5146 pieces of money, each 17*s*. $3\frac{1}{4}d$., as many more, each 4*s*. $3\frac{1}{4}d$., and as many more, each 1*s*. $7\frac{1}{4}d$., how many Napoleons, each 16*s*. $7\frac{3}{4}d$.?

10. Divide 122·122 by ·000625.

11. In the Crimean army of 150,000 men, there were 6 French to every 5 English, 5 English to every 4 Turks, 4 Turks to every Sardinian; how many were there of each?

12. Find the value of 4·6875 of a cwt.

13. If it cost £59 2*s.* 1½*d.* to keep 3 horses for 7 months, how much will it cost to keep 2 horses for 11 months?

14. If a grocer buys 7 cwt. 3 qrs. 14 lbs. for £9 10*s.* 6*d.*, and retains 1 cwt. 1 qr. 5 lbs. for his own use, at what price per cwt. must he sell the remainder, so as to get his own for nothing?

15. A canal is filled by one sluice in 12 days, and by another in 4 days; in what time will it be filled by both together?

PAPER No. 60.

1. Express in words 821·3927.

2. Find the value by practice of 21375 articles at £3 2*s.* 6¾*d.* each.

3. Divide 842·76 by 8·314.

4. Find the value of $\frac{3}{7}$ of 14·21 of £3·24.

5. From $8{\cdot}21\dot{3}\dot{7}$ take $6{\cdot}\dot{2}1\dot{3}$.

6. If I borrowed 2⅓ of £80 and repay ⅙ of what I borrowed, what do I still owe?

7. Find the average of 8, 15, 14, 9½, 6⅓, 4⅔, and 5½.

8. Extract the square root of 821·473.

9. Find the value of 3·4 cwt. at 3·2*d.* per pound.

10. Multiply 8ft. 7′ by 3ft. 2′ 9‴.

11. How many square yards of carpet would it take to carpet a room 15 ft. 6 in. by 12 ft. 9 in.?

12. Reduce £3·456 to the decimal of 8·64 guineas.

13. Divide £24578 between A, B, and C in the proportion of 5, 7, and 8.

14. Which is the greater, $\sqrt{118{\cdot}81}$ or $\sqrt[3]{343}$?

PAPER No. 61.

1. Add together 369 tons 13 cwt. 1 qr. 14 lbs.; 127 tons 1 cwt. 3 qrs. 17 lbs.; 258 tons 19 cwt. 2 qrs. 23 lbs.; and 1 ton 5 cwt. 3 qrs. 2 lbs.

2. Divide $1\frac{3}{8}$ of $2\frac{1}{3}$ by $1\frac{3}{4}$ of $5\frac{1}{2}$.

3. Multiply £628 17*s.* $4\frac{1}{2}$*d.* by 1407.

4. Reduce $\frac{667}{1102}$ to its lowest terms.

5. Divide 375 miles 2 fur. 7 pls. 2 yds. 1 ft. by 39.

6. Reduce $\frac{3}{4}$ of half-a-guinea to the fraction of £1.

7. How many seconds are there in a leap year?

8. Multiply 5·6 by ·00457.

9. Divide £6 16*s.* 9*d.* between two persons, so that one may have double the sum which the other receives.

10. Divide 816 by ·0004.

11. How many times will a coach-wheel, of $18\frac{1}{2}$ feet in circumference, turn round between London and York, the distance being 197 miles?

12. Reduce 7*s.* $4\frac{1}{2}$*d.* to the decimal of £1.

13. If £4 15*s.* $7\frac{1}{4}$*d.* can purchase 3 cwt. 17 lbs., what must be given for 16 cwt. 3 qrs. 12 lbs.?

14. A owes B £56 5*s.*, but B consents to remit 15 per cent. for immediate payment; what sum does A pay to B?

15. If 4 cwt. 1 qr. 7 lbs. cost £5 per cwt., what will be the cost per lb. when the cost of the whole has been reduced by £5 9*s.* 3*d.*?

PAPER No. 62.

1. Multiply 3856900 by 970.

2. Express as a simple fraction $\frac{3}{4}$ of $\frac{5}{8}$ of $7\frac{1}{9}$.

3. The sea route from London to Hamburg is 482 miles; when the London steamer is 130 miles on its way, and the Hamburgh steamer 210 miles on its way, how far are they apart?

4. Add together $\frac{1}{2}$, $\frac{1}{3}$, $\frac{7}{8}$, and $\frac{5}{12}$.

5. If I bought 79 shares in the Great Western Railway at £74 each, and sold them at £76 15*s.* each; what did I pay for them, and how much did I gain?

6. What fraction of £13 4*s*. 6*d*. is £7 9*s*. 6*d*.?

7. A cart with coals weighed 1 ton 15 cwt. 3 qrs. 25 lbs., and the coals alone 19 cwt. 26 lbs.; what was the weight of the cart?

8. Express ·0075 as a vulgar fraction in its lowest terms.

9. How often will the fore wheel of a carriage, 5 ft. 8 in. round, revolve in a journey of 45 miles? and how much oftener than the hind wheel, which is 7 ft. 6 in. round?

10. Multiply ·0002 by 3·01.

11. A company of seven miners find a nugget of gold weighing 23 lbs. 5 oz.; what does each gain by it if gold sells at £3 16*s*. $10\frac{1}{2}$*d*. per oz.?

12. Find the value of ·68125 of £1.

13. A can do a piece of work in 10 days, and A and B can do it together in 7 days; in what time would B alone do it?

14. Divide £79 18*s*. 4*d*. among 4 men, 7 women, and 11 boys, so that each woman may have 3 boys' shares, and each man 4 women's shares.

15. If 24 tons are carried 68 miles for £8 10*s*. 6*d*., for what money will 14 tons be carried 120 miles?

PAPER No. 63.

1. From one hundred tons subtract 10 cwt. 3 qrs. 16 lbs. 10 oz.

2. From $1\frac{1}{15}$ take $\frac{11}{30}$.

3. What is the cost of 8630 yards of cloth at £1 9*s*. 3*d*. per yard?

4. Reduce $\frac{41233}{351386}$ to its lowest terms.

5. Divide 355 tons 13 cwt. 2 qrs. 13 lbs. 12 drs. by 132.

6. Multiply $10\frac{1}{8}$ by $5\frac{1}{9}$.

7. A person bought 11 cwt. 1 qr. of sugar for £48 19*s*. $0\frac{1}{2}$*d*., and sold it at 10*d*. per lb.; did he gain or lose, and how much?

8. From 7·00001 take ·700001.

9. What is the pay of 548 labourers for 15 weeks at 2*s*. $9\frac{1}{2}$*d*. per day?

10. Multiply ·049 by 3·417.

11. A bankrupt pays 14*s.* 7½*d.* in the pound off a debt of £9655; how much do the creditors lose?

12. Divide 1138·47 by 125000.

13. If 4 oz. 15 dwts. of silver plate cost £1 11*s.* 6*d.*, what will five articles, each 3 oz. 12 dwts., cost?

14. If 5 yards of linen cost 11*s.* 2*d.*, what must be given for 9 pieces, each containing 21 yds. 1 qr.?

15. Extract the square root of 172265625.

PAPER No. 64.

1. What number divided by 48762 will give 6285 for quotient and 26108 for remainder?

2. From $\frac{2}{5}+\frac{5}{6}$ take $\frac{3}{8}+\frac{7}{12}$.

3. How many dollars are there in £289 17*s.*, at 4*s.* 3*d.* per dollar?

4. Find the value of $\frac{3}{7}$ of $1\frac{2}{5}$ of $12\frac{1}{2}$ of $\frac{3}{20}$.

5. A stationer buys 36 reams of paper at 16*s.* 6*d.* per ream, and 84 reams at 17*s.* 9*d.* per ream; find his entire outlay.

6. Reduce $\frac{4}{7}$ of a lb. to the fraction of a cwt.

7. If 2 cwt. 1 lb. cost £116 19*s.* 0¾*d.*, what is the cost of 1 lb.?

8. Divide ·0068 by 340, and 314 by ·0005.

9. An equal number of men, women, and boys earned £8 5*s.* in 6 days: each man earned 1*s.* 4*d.*, each woman 10*d.*, and each boy 4*d.* a day; how many were there of each?

10. Extract the square root of 3·026.

11. If the duty on hops at 1½*d.* per lb. amounts to £26357 9*s.* 10½*d.*, on what quantity was it paid?

12. Reduce 16 cwt. 1 qr. 21 lbs. to the decimal of a ton.

13. What will 1 ton 11 cwt. 2 qrs. 14 lbs. cost at £1 13*s.* 7*d.* per cwt.?

14. Extract the square root of 22071204.

15. In what time will 25 men do a piece of work which 12 men can do in 3 days?

PAPER No. 65.

1. There is a number of which, when multiplied by 36, the product is 3294900; find it.

2. Find the difference between $11\frac{1}{11}$ and $9\frac{1}{9}$.

3. A boat moves through 3 miles and 390 yards in 1047 strokes; what is the distance per stroke through which the boat moves?

4. Multiply $7\frac{2}{9}$ by $6\frac{2}{3}$ of $\frac{2}{5}$.

5. Divide £91 11*s.* 6*d.* by 108.

6. Find the value of $1\frac{2}{5}$ of $2\frac{1}{3}$ of a crown.

7. Find the value of 7 tons 14 cwt. 2 qrs. 25 lbs. of hay £3 10*s.* 6*d.* per ton.

8. Add together 72·093, 391·7, 48·0008, and 730·0514.

9. If 9 men complete a piece of work in 16 days 10 hours, how many men would be required to do the same in 24 days, 7 hours?

10. Multiply 1782·7 by ·00006.

11. A merchant bought tea for £259 19*s.* 3*d.*, sugar for £192 0*s.* $5\frac{3}{4}$*d.*, and coffee for £207 11*s.* 6*d.*; what must he sell the whole for to gain one-fourth of what he paid for them?

12. Reduce 7*s.* $4\frac{1}{2}$*d.* to the decimal of £1.

13. What cash must be given with 24 yards of cloth at 8*s.* $3\frac{3}{4}$*d.* per yard to pay for 6 cwt. of sugar at £1 18*s.* per cwt.?

14. What sum will 15 men working 9 hours a day earn in 16 days, if 8 men working 7 hours a day earn £22 15*s.* in 20 days?

15. If A can do a piece of work in 10 days, and A and B can do it together in 7 days, in what time will B alone do it?

PAPER No. 66.

1. Divide £23567 16*s.* 3*d.* by 345.

2. From $\frac{5}{24}+\frac{11}{36}$ take $\frac{17}{72}$.

3. A body of soldiers was formed into a square with 38 men in each side; if they were arranged in a column 39 deep, with 30 men in front, how many would be over?

4. Divide $11\frac{3}{7}$ by $2\frac{6}{7}$.

5. On leaving home A had a five-pound note in his pocket, but he pays to B two-thirds of it, and to C three-fourths of what remained; how much had A now remaining?

6. Reduce $\frac{5}{7}$ of 1*s.* 2*d.* to the fraction of 5*s.* 10*d.*

7. What will 2 cwt. 3 qrs. 4 lbs. of raisins come to at £2 12*s.* 6*d.* for three-quarters of a cwt.?

8. From 18·714 take 5·31705.

9. A bankrupt owes me £360 16*s.* 3*d.*, for which I only get £240 10*s.* 10*d.*; how much in the pound is that?

10. Reduce ·00875 to a vulgar fraction in its lowest terms.

11. What length must be cut off a board that is $6\frac{3}{4}$ inches broad, to contain a square foot?

12. Find the value of ·7375 of £6.

13. If 3 cwt. of tea cost £40 12*s.*, at how much a pound must it be retailed to gain £10 by the whole?

14. What is the interest of £712 6*s.* for 8 months at $7\frac{1}{2}$ per cent. per annum?

15. Three merchants, whose stock is £720, of which A contributed £123, B £558, and C the rest, gain by trading £125 10*s.*: what must each have of it?

PAPER No. 67.

1. What sum added to £43 14*s.* $3\frac{3}{4}$*d.* will make 48000 farthings?

2. Add together $\frac{1}{4}$, $\frac{5}{12}$, $\frac{7}{15}$, and $\frac{3}{20}$.

3. How often will a wheel, $3\frac{1}{4}$ yards in circumference, turn in a distance of 104 miles?

4. Reduce $\frac{7040}{7192}$ to its lowest terms.

5. Divide £89075 12*s.* 6*d.* by 576.

6. If $\frac{7}{24}$ of the cargo of a ship be worth £714 14*s.*, what is the value of the cargo?

7. How many pounds of silver are there in 270 spoons, each weighing 1 oz. 13 dwts. 8 grs.?

8. Add together 35·2176, 201·00541, 3·1482, ·054, and 7543·4.

9. If the carriage of 107 cwt. 10 lbs. cost £39 9*s.* 7$\frac{1}{2}$*d.*, what would the carriage of a ton cost?

10. Divide 27·5264 by ·0374.

11. If 5 pieces of cloth, each containing 12 yards, cost £17 10*s.*, what will 22 yards cost?

12. Find the value of £·36875.

13. If 161 lbs. of tea are given in exchange for 12 cwts. 21 lbs. of sugar at 5$\frac{3}{4}$*d.* per lb., what is the price of tea per lb.?

14. A person buys 4 cwt. 3 qrs. 14 lbs. of sugar at £2 16*s.* 8*d.* per cwt., and sells it at 8$\frac{1}{2}$*d.* per lb.; how much does he gain or lose?

15. If 15 men in 9 days can reap a field, how long will 10 men require to reap a field twice the size?

PAPER No. 68.

1. How many tons, cwts., &c., are there in 195328 ounces avoirdupois?

2. Express as a single fraction $\frac{3}{7}$ of 2$\frac{1}{9}$ of 2$\frac{4}{19}$.

3. What is the rent of 179 acres of land, at £1 11*s.* 3*d.* per acre?

4. Find the least common multiple of 4, 9, 36, 48, 56, 144.

5. How many pieces of coin of 1*s.* 2$\frac{1}{4}$*d.* each are there in £2120 8*s.*?

6. Add together $\frac{1}{3}$ of $\frac{5}{7}$, $\frac{1}{4}$ of $\frac{19}{21}$, and $\frac{5}{6}$ of $\frac{9}{14}$.

7. If 21 lbs. 5 ozs. 12 drs. cost £109 9*s.* 9*d.*, what is the price per ounce?

8. Multiply 814·632 by ·0378.

9. What is the price of 53 cwt. 3 qrs. 7 lbs. at £73 15*s.* 6*d.* per cwt.?

10. Divide 4·8 by ·00016.

11. Divide £11 5*s.* 10*d.* between three persons in such manner that one of them shall receive three times as much as either of the others.

12. Reduce 18*s.* 4$\frac{1}{2}$*d.* to the decimal of £1.

13. Extract the square root of 5764801.

14. If the carriage of 4 cwt. 3 qrs. for 160 miles be

£3 17*s.*, what will be the carriage of 11 cwt. 3 qrs. 14 lbs. for 100.

15. By selling a horse for £116 17*s.* a person lost 5 per cent.; what will be his gain or loss per cent. if he sells him for £132 4*s.* 6*d.*?

PAPER No. 69.

1. If the product be 26299989276, and the multiplicand 800706, what is the multiplier?

2. Multiply $5\frac{2}{3}$ by $2\frac{3}{5}$.

3. Prize money to the amount of £51684 8*s.* $5\frac{1}{4}$*d.* is to be divided equally among 5793 men; what will be each man's share?

4. Reduce $\frac{10767}{203021}$ to its lowest terms.

5. Divide £97 16*s.* 3*d.* into guineas, crowns, and pence, and of each an equal number.

6. What fraction of a pound is $\frac{5}{6}$ of a penny?

7. If wine be sold at £2 4*s.* a dozen, what is the price of 15 dozen and 8 bottles?

8. Divide ·429408 by 59·64.

9. A grocer bought 3 chests of tea, which weighed together 7 cwt. 1 qr. 17 lbs.; one of them weighed 22 lbs. more than either of the others: what were their respective weights?

10. Multiply ·002576 by ·038.

11. If a piece of plate that weighs 7 oz. 9 dwts. 15 grs. cost £11 12*s.* 2*d.*, how much of it costs £1 13*s.* 2*d.*?

12. Find the value of 4·6875 of a cwt.

13. How much per cent. is gained by purchasing at $10\frac{1}{2}$ guineas per cwt., and selling at 2*s.* 3*d.* per lb.?

14. If 7 men earn £19 1*s.* in 21 days, what sum will 14 men earn in 63 days?

15. Find the interest of £690 for 5 months at 5 per cent. per annum.

PAPER No. 70.

1. Divide £412 0*s.* $2\frac{1}{2}$*d.* by 370.

2. Reduce $\frac{1407}{4422}$ to its lowest terms.

3. Find the exact length of the lunar month in days, hours, &c., if it contain 2551443 seconds.

4. Express as a simple fraction $3\frac{5}{9}$ of $2\frac{1}{4}$ of $\frac{3}{8}$ of $\frac{7}{15}$.

5. What is the price of 18 packs of cloth, each containing 9 parcels, and each parcel 8 pieces, and each piece 40 yards, at $2\frac{3}{4}$*d.* per yard?

6. Reduce 2*s.* $6\frac{1}{2}$*d.* to the fraction of 6*d.*

7. The circumference of a coach-wheel being 16 ft. 6 in., how often will it turn round in a journey of 118 miles?

8. Add together 321·4, 12, 31·6154, ·01, 2·214, and 415·62.

9. Divide £346 10*s.* among 5 men and 6 boys, giving to each man 3 times as much as each boy.

10. Divide 1 by ·013.

11. A farmer sold at a market 143 sheep at £1 19*s.* 9*d.* each, and bought 16 oxen at 16 guineas each; what money did he carry home?

12. At 3*s.* $4\frac{1}{2}$*d.* for 4·6 lbs., what is the price of 14·375 lbs.?

13. A bankrupt pays $10\frac{1}{2}$*d.* in the pound, and the payment is £51 6*s.* 8*d.*; what was his debt?

14. A can do a piece of work in 10 days which B could do in 13; in what time would they do it together?

15. How must wine which cost 15*s.* per gallon, be sold so as to gain 21 per cent.?

PAPER No. 71.

1. A body of soldiers can be arranged in a column with 30 men in front and 24 in depth; how many more are wanted to make a square with 32 men in front and 32 in depth?

2. From $4\frac{5}{8}$ take $\frac{17}{9}$.

3. A farmer bought 29 bullocks for £377, and after keeping them for 3 months and spending on each £1 per month, he sold them all for £522; what was his gain on each bullock?

4. Multiply $\frac{5}{9}$ of $\frac{8}{12}$ by $\frac{6}{7}$.

5. Multiply £9 19*s.* $7\frac{3}{4}$*d.* by 42.

6. What part of £2 is $\frac{4}{5}$ of a half-guinea?

7. Find the value of 136 cwt. 2 qrs. 4 lbs. at £1 11*s.* $1\frac{1}{4}$*d.* per cwt.

8. From one hundredth take one ten-thousandth.

9. The weight of a package containing 31 parcels is 418 cwt. 3 qrs. 3lbs.; what is the weight of each parcel?

10. Divide ·011214 by 53·4.

11. A tower 103 ft. high cast a shadow 79 ft. 3 in. long; what was the height of a tower whose shadow at the same time extended 52 ft. 10 in.

12. Find the value of £·365625.

13. If I gain 10 per cent. by selling tea at 6*s.* per lb., what do I gain or lose per cent. by selling it at 5*s.* 10*d.* per lb.?

14. How many ounces of silver at 5*s.* 6*d.* per ounce are equivalent to 6 oz. 12 dwts. of gold at £3 17*s.* $10\frac{1}{2}$*d.* an ounce?

15. Divide £800 among A, B, and C, so that B shall have 3 times as much as A, and C half as much as B.

PAPER No. 72.

1. How many times must 3748 be added to itself to make a total of 333572?

2. Add together $\frac{1}{6}$, $2\frac{1}{7}$, and $13\frac{3}{10}$.

3. Divide 1238 yds. 2 ft. 10 in. by 29.

4. Multiply $\frac{3}{4}$ of $\frac{1}{5}$ by $17\frac{1}{2}$.

5. A has seven thousand four hundred and one oranges; he sells B fifty-seven dozen and five; C, one hundred and twelve dozen and eleven; D, two hundred and fifty-nine dozen and nine; and E the remainder: how many did E purchase?

6. Find the value of $2\frac{3}{7}$ of £15.

7. A person's income is reduced from £750 to £734 7*s.* 6*d.* by income-tax; how much does he pay in the £?

8. Divide 7792 by ·37.

9. Find the value of 7 chests of tea, each weighing 2 cwt. 1 qr. 13 lbs., at £23 4*s.* 4*d.* a cwt.

10. From 26·002 take 18·9564.

11. A grocer buys a cask of sugar containing 6 cwt. 39 lbs. for $17\frac{1}{2}$ guineas, and retails it at 3 guineas a cwt.; find his gain.

12. Reduce 6*s.* $10\frac{1}{4}$*d.* to the decimal of a £.

13. Extract the square root of 28547649.

14. Tea is bought at £22 8*s.* per cwt.; at what price per lb. must it be sold to gain 25 per cent.?

15. A ship was provisioned for a crew of 84 men for 5 months; how much longer would the provisions last if a crew of sixty men only were taken on board?

PAPER No. 73.

1. If the dividend be 5506, the quotient 423, and the remainder 7, what is the divisor?

2. Add together $1\frac{1}{3}$ of $2\frac{1}{2}$ and $6\frac{1}{4}$.

3. A man has gold and silver in his purse amounting to £3 2*s.* 6*d.*; the value of the gold is four times that of the silver: find the value of the gold.

4. What number divided by $1\frac{3}{8}$ will produce $10\frac{8}{11}$.

5. Divide 18 lbs. 5 dwts. 3 grs. by 106.

6. Find the value of $\frac{3}{5}$ of $7\frac{1}{2}$ guineas.

7. A bankrupt, whose debts amount to £50043, pays 6*s.* $0\frac{1}{4}$*d.* in the £; what are his effects worth?

8. Add together 27·5037, ·042, 342, 2·1, and 1·87359.

9. A farmer gave £21 18*s.* 8*d.* for 14 sheep; 3 of them died; at what rate per head must he sell the rest in order to gain £1 18*s.* by his bargain?

10. Divide 17·1031 by ·00053.

11. A merchant exchanged 1134 yards of velvet for 5313 yards of silk at 3*s.* $4\frac{1}{2}$*d.* per yard; find the value of the velvet per yard.

12. Find the value of ·815 of 15*s.* 6*d.*

13. Extract the square root of 4937284.

14. If a regiment of 1878 soldiers consume 702 qrs. of wheat in 336 days, how many qrs. will an army of 22536 men consume in 112 days?

15. Between the years 1841 and 1851 the population of England increased 14·5 per cent.; in 1851 it was 211 1290; what was it in 1841?

PAPER No. 74.

1. Subtract seventy thousand and eighty-nine from one hundred thousand and ten, and subtract the difference of the sum of the same two numbers.

2. Find the difference between $4\frac{5}{8}$ and $\frac{17}{9}$.

3. Multiply 83 lbs. 17 dwts. 5 grs. by 131.

4. Find the least common multiple of 25, 60, and 45.

5. If 1 cwt. of sugar cost £2 13*s*. 8*d*., what is that per pound?

6. Find the value of $3\frac{5}{11}$ of 14*s*. 8*d*.

7. A man has a bag containing 2843 half-guineas; how much ought he to receive for the contents in pounds, shillings, and pence?

8. Divide 7·619 by ·0019.

9. How many parcels of 6 lbs. and 8 lbs. each can a grocer make out of a cask of sugar containing 4 cwt. 3 qrs. 14 lbs. so as to have the same number of parcels of each sort?

10. Reduce 1·348 to a vulgar fraction in its lowest terms.

11. The value of silver being 5*s*. $7\frac{1}{2}$*d*. per ounce, find the value of a silver tankard weighing 4 lbs. 8 oz. 10 dwts.

12. Add together 5·35 tons and 6·39 cwt.

13. A person bought a barrel of beer (36 gallons) for £3 3*s*., and retailed it at $3\frac{1}{2}$*d*. per pint; was there a gain or loss, and how much?

14. Find the square root of 263169.

15. 1 lb. of silver being worth £3 6*s*., find the price of a salver weighing 7 lbs. 7 oz. 10 dwts., subject to a duty of 1*s*. 6*d*. an ounce and a charge of 1*s*. 10*d*. an ounce for workmanship.

PAPER No. 75.

1. Required to pay £144 in moidores and sovereigns, in exactly 130 coins; how many are there of each?

2. Find the value of ·375 of a guinea + $\cdot\dot{5}\dot{4}$ of 8*s*. 3*d*. + $\cdot 0\dot{2}\dot{7}$ of £2 15*s*.

3. Telegraphic posts are to be placed at the equal distance of 22 yards from each other; how many posts will there be in a distance of 125 miles?

4. If the ratio of A to B is 6 to 9, and that of B to C 8 to 10, what is the simplest form for the ratio of A to C?

5. Two places, A and B, are distant from each other 324 miles by railway. A train leaves A for B at the same time that a train leaves B for A; the trains meet at the end of 6 hours, the train from A to B having travelled 16 miles an hour more than the other: how many miles did each travel an hour?

6. A boatman finds he can row 4 miles against the tide, and 6 miles with the tide; what is the velocity of the tide?

7. Two shepherds, A and B, owning a flock of sheep agree to divide it; A takes 144 sheep, and B takes 184 sheep and pays £70 to A; required the value of a sheep.

8. If $\frac{1}{10}$ of a mine is worth £20,000, what is the value of $\frac{2}{3}$ of it?

9. What would be the cost of painting the four walls of a room whose length is 24 ft. 3 in., breadth 15 ft. 8 in., and height 11 ft. 6 in. at 4*s.* the square foot?

10. Reduce $4 - \dfrac{\frac{1}{2} + \frac{1}{3}}{\frac{1}{4} - \frac{1}{6}}$ to its simplest form.

11. The cargo of a ship belongs to three partners, and is sold for £45,000; one owns $\frac{1}{3}$, another $\frac{7}{15}$ths. What part is owned by the third partner? and what ought each to receive from the sale?

12. Express as vulgar fraction $7\cdot\dot{2}8571\dot{4}$.

13. In the 3 per cents., what fraction of a given amount of stock is paid for annual interest (1) without any deduction, (2) after 9*d.* in the pound has been deducted for income-tax?

14. What is the amount of stock for which £115 10*s.* is paid as annual interest, after 9*d.* in the pound has been so deducted?

15. Express $\frac{1}{5}$ of 13*s.* 4*d.* as the fraction of £5.

PAPER No. 76.

1. Two men or five women can do a certain piece of work in 12 days; what time would 4 men and 1 woman be performing the same?

2. Divide ·011214 by 5·34 and ·00329875 by ·0754.

3. Would a person increase or diminish his income by selling £1157 3 per cent. stock at $83\frac{1}{4}$ to purchase into the $3\frac{1}{4}$ per cents. at $83\frac{7}{8}$?

4. Find the value of $\frac{3\frac{1}{2} - \cdot 04}{5 - \cdot 0625}$ as a vulgar fraction.

5. One vessel M contains a mixture of 27 gallons of wine and 11 of spirits; another vessel N contains a mixture of 43 gallons of wine and 14 of spirits. Compare the strengths of the two mixtures, supposing the strength of spirits to be three times that of wine.

6. How many 3-inch cubes can be cut from a 12-inch cube?

7. Find by the rule of practice the cost of 5 cwt. 2 qrs. 15 lbs. of goods at £27 for 1 cwt.

8. What number is that, from which if there be taken $\frac{2}{7}$ of $\frac{3}{8}$, and to the remainder be added $\frac{8}{15}$ of $\frac{5}{16}$, the sum will be 10?

9. Divide the number 237 into three parts, such that 3 times the first may be equal to five times the second and to 8 times the third.

10. If a pond is 50 ft. long, 20 ft. broad, and 4 ft. deep, what depth must another pond be dug out so that the earth may fill up the former pond if it is only made 30 ft. long 15 ft. broad?

11. What length of matting $\frac{3}{4}$ yd. wide will cover the floor of a hospital hut 30 ft. 6 in. long by 18 ft. 9 in. wide?

12. A person observing a float and taking hold of it, found it attached to a string from the bottom, which, when pulled perpendicular, was 3 ft. above the water; and when pulled forwards it was submerged at a distance of 12 ft: what was the depth of the water?

13. A person has $\frac{1}{6}$ of a ship, worth £3,484, which is

insured for $91\frac{2}{3}$ per cent. of its real value; what would he lose in case of the ship being lost?

14. Divide £2,025 among A, B, C, D, E, so that A's share : B's share :: 1 : 2; C's share : B's share :: 5 : 4; D's share : C's share :: 6 : 5; and E's share : D's share :: 4 : 3.

15. Simplify $2\frac{1}{3} + \dfrac{\frac{4}{5} \text{ of } 2\frac{1}{2} - \frac{2}{3}}{4\frac{1}{5} - 2\frac{3}{10}}$.

PAPER No. 77.

1. How many revolutions will the wheel of an engine, whose circumference is 15 ft., make in travelling from Fareham to Botley, a distance of $7\frac{1}{2}$ miles? By how many would the number of revolutions have been diminished if the diameter of the wheel had been 1 inch greater?

2. A gentleman contributed to two charitable institutions a sum of £90 in sovereigns and half-crowns; the total number of coins paid was 370: find what was the number of each.

3. If the hands of a clock be together at 12 o'clock, when will they be together again?

4. Simplify $\dfrac{(\frac{1}{2})^2 + (\frac{2}{3})^2 \times \frac{1}{5} \text{ of } \frac{2}{3}}{\sqrt{\frac{4}{9}} - \sqrt[3]{\frac{8}{125}}}$.

5. If a beam which is 10 in. wide, 8 in. deep, and 5 ft 6 in. long, weigh 8 cwt. 1 qr., find the length of another beam, the end of which is a square foot, which shall weigh a ton.

6. Divide ·014904 by $3\frac{6}{25}$; and divide 14·904 by ·000324.

7. Find the expense of painting the outside of a cubical iron chest, whose edge is 2 ft. 5 in., at 1*s.* 3*d.* per square yard.

8. A father left his two sons his property, which realised £30,000; the elder invested in the consols 3 per cents., at 93; the younger in the Queensland debentures, 6 per cents., at 108; and their incomes, thus derived, were in the ratio of 2 to 3: what share of the property had each?

9. If a drove of 50 New Forest and Exmoor ponies, composed of 30 of the former and 20 of the latter, are

worth £550; and another drove of 30, of which 12 are New Forest and 18 Exmoor, are worth £336: what is the average price of an Exmoor pony?

10. Find the expense of carpeting a room 14 ft. 6 in. long, by 18 ft. 9 in. broad, and 4*s.* 2*d.* per square yard.

11. Multiply the sum of $\frac{3}{5}$ and $\frac{5}{6}$ by their difference, and divide the product by $8\frac{3}{5}$.

12. Find the vulgar fraction equivalent to

$$\cdot 8\dot{3} + \cdot\dot{6}\dot{3} + \cdot 7\dot{3}.$$

13. 650 horses are conveyed in transports to the seat of war at a cost for food of £1,542. A storm occurs just after one-fourth of the voyage is completed, in which 10 horses are killed. If the expense of the food of each horse be 1*s.* per day, what was the length of the voyage?

14. Two numbers have for their greatest common measure 179, and for their least common multiple 56385. What must the greater number be, if the lesser is $= 105$ times $\dfrac{2\frac{6}{7}}{4\frac{5}{6}}$ of $\dfrac{363\cdot37}{8\cdot4}$?

15. What will be the cost of painting the walls of a room at 1*s.* 7*d.* per square yard, the length being 19 ft. $10\frac{1}{4}$ in., the breadth 16 ft. $1\frac{3}{4}$ in., and the height 10 ft. 3 in.? Solve by decimals.

PAPER No. 78.

1. Express in words 426·00021.

2. Find the value of 1·24 ton + 3·5 cwt. + ·68 qrs. + 1·25 lbs.

3. What will be the income-tax, at 7*d.* in the pound, on £257 10*s.*?

4. A father left his two sons £40,000; the elder invested his share in the 3 per cents. at 90, and the younger his share in the 4 per cents. at 94, and procured the same income; what was the share of each son?

5. The estate of a bankrupt, £21,000, is to be divided among four creditors, whose debts are—A's to B's as 2 : 3,

B's to C's as 4 : 5, C's to D's as 6 : 7; what must each receive?

6. The prime cost of a 50-gallon cask of wine is £25, and 10 gallons are lost by leakage; at what price per gallon must the remainder be sold, so as to gain 10 per cent. on the whole original cost?

7. If a pound of silver cost £3 6*s*., what is the price of a cup which weighs 10 lbs. 6 oz. 10 dwts., subject to a duty of 1*s*. 6*d*. per oz., and also to a charge of 1*s*. 9*d*. per oz. for workmanship?

8. Reduce to its simplest form $3\tfrac{1}{2} + \dfrac{\tfrac{1}{4} \text{ of } 2\tfrac{1}{3}}{\tfrac{1}{4} \div 1\tfrac{1}{2}} - 2\tfrac{1}{3}$.

9. What ought to be the value of £135 in the $4\tfrac{1}{2}$ per cents. when the 3 per cents. are at $97\tfrac{1}{8}$?

10. Reduce $\tfrac{3}{7}$ of a farthing to the fraction of 4*s*. $2\tfrac{1}{2}$*d*.

11. Find the square root of 30·0625, and the cube root of 2116·874304.

12. Add together 4·56 tons, 8·3 cwt. and 6·2 lbs.

13. A farm lets for £92 per annum; the tenant pays for 2 years' occupation, with interest accumulating at 5 per cent.; the landlord pays $\tfrac{1}{4}$ the amount for repairs of house, $\tfrac{1}{3}$ of this for repairs of barn, and £2 3*s*. 4*d*. for other expenses: find the balance.

14. A person gives 100 guineas for a pipe of wine, which contains 52 dozen bottles; what does his wine cost him a dozen if he has to keep it ten years in bottle, and 4 per cent. simple interest be allowed on the outlay?

15. Simplify the expression

$$\sqrt[3]{\frac{\frac{5}{16} + \frac{7}{12} \text{ of } 3\frac{1}{4} - \left(\frac{7}{8} \text{ of } \frac{37}{21} - \frac{1}{3}\right)}{\frac{5}{14} - \frac{3}{7} \text{ of } \frac{1}{2}} \times 49}.$$

PAPER No. 79.

1. A is twice, and B is just one and a half times, as good a workman as C. The three work together for two days, and then A works on alone for half a day, and B for

one day. How long would it have taken A and C together to complete as much as the three will have thus performed?

2. A farmer bought 50 sheep for £200; 4 having died, at what price per sheep must he sell the remainder to gain 10 per cent. by his bargain?

3. In the Centigrade thermometer the freezing-point is zero, and the boiling-point is 100°; in Fahrenheit's the freezing-point is 32°, and the boiling-point is 212°: what degree C. corresponds to 68° F.?

4. How much water must be added to a cask containing 80 gallons of spirits at 14*s.*, to reduce the price to 10*s.* 6*d.*?

5. A person buys teas at 3*s.* and 4*s.* the pound, and mixes them in the proportion of 4 : 7; what will he gain per cent. by selling at 3*s.* 9*d.* per pound?

6. A tradesman starts with a capital of £960, and after 3 years takes another into partnership with £2,100; after 4 years more the whole profits amount to £2,304. How ought this to be divided between them?

7. Bought goods for £150, ready money, and sold them for £200, payable ¾ of a year hence; what was the gain in ready money, discount being 4½ per cent.?

8. What is the rate of exchange between London and Paris when securities, which are sold at Hamburg for 13 marks 10 schillings per £1 sterling, and bought at Amsterdam at 35·05 florins for 40 marks, will purchase French securities at the rate of 58 florins for 120 francs?

9. For what sum should a cargo, worth £5263, be insured, at 7⅔ per cent., so that the owner may recover, in case of loss, the value both of cargo and premium?

10. Divide £107 10*s.* into moidores and four-shilling pieces, so that there shall be exactly 250 coins.

11. If 10 horses and 8 cows are together worth £372, and four horses and 2 cows worth £144; find the price of a cow.

12. What is the net weight of 7 barrels of figs, each weighing 2 cwt. 1 qr. 12 lbs.; tare 21 lbs. per cwt.?

13. Convert £246 15*s.* 6*d.* into piastres and rials, exchange being at 47½*d.* a piastre (1 piastre = 8 rials).

14. A piece of cloth, when measured with a yard measure

two-thirds of an inch too short, appears to be $10\frac{1}{2}$ yards long; what is its true length?

15. If 5 men can reap a field, in length 800 ft., and breadth 700 ft. in $3\frac{1}{2}$ days of 14 hours each, in how many days of 12 hours each will 7 men reap a field 1800 ft. by 960 ft.?

PAPER No. 80.

1. Find the time between 3 and 4 o'clock when the hour and minute hand of a watch are exactly together.

2. A father bequeathed to his son $\frac{13}{20}$ of his estate, and the rest to his daughter. When the legacies came to be paid, one amounted to £1,200 more than the other; what did the testator die worth?

3. A druggist has two sorts of bark worth 5*s.* 9*d.* and 10*s.* per lb.; what portion of each must he take to make a mixture of $1\frac{1}{2}$ cwt. that shall be worth 8*s.* 6*d.* per pound?

4. A man sells a horse for £39 12*s.*, and loses 12 per cent. on what the horse cost him; what did he give for the horse?

5. Reduce to its equivalent vulgar fraction $\cdot 027\dot{0}2\dot{7}$.

6. A coach goes 9 miles an hour, and a railway-train goes 23 miles while the coach goes 11 miles; how much time will be saved in a journey of 138 miles by taking the train instead of the coach?

7. A, B, and C rent a field for £60; A put in 20 horses, B 15 oxen, and C 10 sheep; supposing the keep of a horse, ox, and sheep to be in the ratio of 3, 2, and 1, show how the rent should be divided.

8. If a tradesman gains 3*s.* $4\frac{1}{2}$*d.* upon an article that cost him 15*s.* 9*d.*, how much does he gain per cent.?

9. If the wages of 8 persons for 21 weeks be £62, what will be the wages of 14 persons for 52 weeks?

10. A cistern 6 ft. deep contains 720,000 cubic in and its base is a square; find a side of the square.

11. How much ought the price of the 3 per cent. consols to sink below par that a broker may be enabled to obtain 4 per cent. for his money?

12. Extract the cube root of 1004004.

13. A man, after doing $\frac{3}{8}$ths of a piece of work in 30 days, is assisted by another, with whom he completes it in 6 days; how long would each be about it separately?

14. Having laid out £165 15*s.* in wine at 4*s.* 3*d.* a gallon, and some of it receiving damage, I sold the rest at 6*s.* 4*d.* a gallon, which produced only £101 16*s.* 8*d.*; what quantity was damaged?

15. A cistern is filled by a tap A in a quarter of an hour, and by a tap B in 25 minutes, and it is emptied by a tap C in 30 minutes; in what time will it be filled if the three taps be all open together?

PAPER No. 81.

1. A regiment of 1,000 men is to be newly clothed, each coat to contain $2\frac{1}{2}$ yards of cloth of $1\frac{1}{4}$ yards wide, and to be lined with shalloon of $\frac{3}{4}$ yard wide; how many yards of each will there be?

2. If $\frac{1}{7}$ of a sheep be worth $\frac{2}{3}$ of a pound, and $\frac{3}{5}$ of a sheep worth $\frac{1}{14}$ of an ox, how much must be given for 100 oxen?

3. Express $\cdot 378\dot{2}1\dot{6}$ as a vulgar fraction in its lowest terms.

4. If a coach travelling 9 miles an hour occupies 4 hours more than a railway-train in a journey of 69 miles, show that the train goes $2\frac{1}{11}$ times as fast as the coach.

5. My chronometer at noon on Monday marked 11 hr. 56 min. $4\frac{41}{48}$ sec., and it is known to gain 3 min. 10 sec. a day; what will be the error in the time shown by it on the following Saturday at 10·15 A.M.?

6. Two clocks point to 12 o'clock at the same instant; one loses 7 sec. and the other gains 8 sec. in 24 hours; when will one be half an hour before the other?

7. From two stations 112 miles apart, two trains start at 2 hrs. 15 min. P.M., towards each other, one at 25 miles an hour and the other at 32 miles an hour; at what time will they meet?

8. If 100 lbs. of tea be bought at 4*s.* 4*d.* and sold at 5*s.*, and 100 lbs. of sugar bought at 6*d.* be sold at 7*d.*, what profit per cent. would be realised by the outlay ?

9. What will be the expense of painting a wall 23 ft. 6 in. by 10 ft. 4 in. at 5*s.* 6*d.* per square yard ?

10. How many leaden balls, 2 inches in diameter, may be cast if a ball, 14 inches diameter, be melted down for that purpose ?

11. A ship is worth £16,000, and a person, possessing $\frac{3}{8}$ of her, sells $\frac{5}{16}$ of his share; what is the remainder of his share worth ?

12. If 5 balls of lead weigh as much as 9 of iron, and 3 of iron as much as 7 of marble, how many balls of marble will be equal in weight to 35 balls of lead ?

13. I bought 40 oxen for £500 and sold 12 at a loss of 3 per cent.; at how much must I sell the rest per head so as to be free from loss on the whole ?

14. Five hundred boys are distributed in 3 houses; the smallest house contains $\frac{7}{25}$ of the whole number, and the largest contains $\frac{19}{14}$ of the smallest: what are the numbers in each ?

15. Standard gold is formed by a mixture of 11 parts of fine gold with one part of copper; how many sovereigns will be coined from 4 oz. avoirdupois of fine gold when a pound troy of standard gold is coined into $46\frac{29}{40}$ sovereigns ? (A pound avoirdupois = 7,000 grains troy.)

PAPER No. 82.

1. Divide £3 19*s.* 9*d.* between two persons, so that one shall receive half as much again as the other.

2. How many roubles at 3*s.* $4\frac{1}{2}$*d.* each are equal in value to 378 Napoleons at 15*s.* $9\frac{3}{4}$*d.* to the Napoleon ?

3. A draper loses 8 per cent. by selling cambric at 7*s.* 8*d.* per yard; what was the cost price ?

4. What is the cost of paper for the walls of a room 20 ft. long, 12 ft. broad, 11 ft. high, at 4*d.* per yard ?

5. A owned $\frac{2}{3}$ of a mine, he sold $\frac{1}{4}$ to B, and the remainder to C for £12,000; what was the worth of the mine ?

6. A house and garden cost £890; the price of the house was to that of the garden as 8 to 2: find the value of each.

7. Find the least fraction which, added to the sum of $\frac{3}{4}$, $\frac{7}{8}$, and $\frac{5}{12}$, shall make the result a whole number.

8. Find the value of $\dfrac{4\frac{4}{15} \text{ of } 2\frac{5}{8}}{5\frac{1}{5} - 4\frac{1}{2}}$ of £10.

9. How many square feet of glass are required to glaze 5 windows, each containing 14 panes of glass, the panes measuring 17 in. by 15 in.?

10. A man mixes 20 gallons of ale, which has cost him 11*d.* per gallon, with 65 gallons of beer, which has cost him 9*d.* per gallon; at what price must he sell the mixture per gallon to gain 20 per cent. on the outlay?

11. A gardener has a piece of matting 73 yds. 1 ft. 8 in. long, and 3 ft. 9 in. broad, to cover a wall 94 ft. long and 10 ft. high; how many square feet of wall will remain uncovered?

12. Gunpowder being composed of nitre 15 parts, charcoal 3 parts, and sulphur 2 parts, find how much of each is required in making 16 cwt. of powder.

13. If 1 lb. avoirdupois = 7,000 grains troy, and 1,869 sovereigns weigh 50 lbs. troy, how many sovereigns will weigh 1 ounce avoirdupois?

14. Find how much sheet lead will be required to line a rectangular cistern 10 ft. 6 in. long, 6 ft. 4 in. wide, and 5 ft. 9 in. deep; and also find the cost of it at 1*s.* 8*d.* per square foot.

15. A mixture of salt and water contains 25 per cent. of salt; how many gallons of water must be added to 730 lbs. of this mixture that it may contain only 20 per cent. of salt, supposing that a gallon of water weighs 10 lbs. avoirdupois?

PAPER No. 83.

1. Divide $\dfrac{2\frac{4}{11}}{2\frac{3}{5}}$ by $\dfrac{2\frac{7}{11}}{8\frac{7}{10}}$.

2. There is a mixture of three different kinds of wine, in

which for every 3 gallons of one kind there were 4 of another and 7 of a third: what quantity of each is in 294 gallons?

3. How many bricks will be required to build a wall 20 yds. long, $7\frac{1}{2}$ ft. high, and 15 in. thick, supposing a brick to be 9 in. long, $3\frac{1}{2}$ in. wide, and $2\frac{1}{2}$ in. deep?

4. Share £300 between A and B, so that A may have twice as much as B.

5. If the shilling loaf weigh 3 lbs. 9 oz. when flour is at £1 per cwt., how much should it weigh when flour sells at £1 6*s.* 8*d.* per cwt.?

6. Find average of 7, 9, 20, $2\frac{1}{2}$, $4\frac{1}{4}$, $5\frac{1}{4}$, and 8.

7. There are five partners in a business which produces £2,100 profit; the senior partner has 6 shares, the second 5 shares, and the three junior partners 1 share each. What does each receive?

8. The sum of £4,000 is invested in the 3 per cents. when consols are at 92; on the consols rising to 95 it is sold out, and the money put out at 5 per cent. What is the increase of income?

9. Find the respective times between 7 and 8 o'clock when the hour and minute hands are (1) exactly opposite each other, (2) at right angles to each other, (3) coincident.

10. What is the value in English money of 1556·85 francs, when the exchange is 24·25 francs per £?

11. If the painting of a wall 25 ft. by 15 ft. cost £10, what would be the cost of painting a wall 45 ft. by 12 ft.?

12. 5760 lbs. avoidupois being equivalent to 7000 lbs. troy, find the number of drams avoirdupois in a pound troy.

13. A post has $\frac{1}{5}$ of its length in the mud, $\frac{1}{4}$ in the water, and 12 ft. 6 in. above the water; what is the length of the post?

14. Find the present worth of £450 due 4 months hence at 4 per cent.

15. Find the cost of papering a room, 19 ft. 3 in. wide, 24 ft. 4 in. long, and $13\frac{1}{2}$ ft. high, with paper $2\frac{3}{4}$ ft. wide, which cost 11*s.* per piece of 12 yds.; the windows, &c., which do not require papering, making up a sixth part of the whole.

PAPER No. 84.

1. Find the discount on £275 6*s.* 8*d.* due 18 months hence, interest at $4\frac{1}{4}$ per cent. per annum.

2. A, B, and C together have done a piece of work in 3 days; B alone has done it in $6\frac{1}{2}$ days, and C alone in $8\frac{1}{4}$ days: in what time may A alone undertake to do it?

3. If 16 yds. of cloth be worth 6 lbs. of tea, and $4\frac{1}{2}$ lbs. of tea cost a guinea, and if corn be sold at 48*s.* a quarter, what quantity of corn can be obtained for $12\frac{1}{2}$ yards?

4. Find the cost of carpeting a room 12 ft. 4 in. by 16ft. 3 in. at £1 5*s.* per square foot.

5. A straight line is 3 ft. 4 in. long; divide it into two parts which shall be to each other as 5 : 7.

6. There are 1,200 workmen employed in a work which they can complete in 12 weeks; but at the end of 2 weeks 300 workmen are added, and 2 weeks after that 500 are withdrawn. How long should the work last?

7. Find how many yards of paper $\frac{7}{8}$ of a yard wide will paper a room whose length is 26 ft. 4 in., its breadth 18 ft. 8 in., and its height 12 ft. 3 in.

8. If 10 lbs. 3 oz. of tea, at 4*s.* 8*d.* per pound, be mixed with 23 lbs. 3 oz. at 5*s.* 4*d.*, and 17 lbs. 11 oz. at 6*s.* 8*d.*, and the mixture be sold at 6*s.* 1*d.* per pound, what will be the gain or loss?

9. The large-grained powder of the English service weighs 55·5 lbs. per cubic foot; find the number of cubic inches which would be occupied by 1 oz. of this powder, and the weight of 1152 cubic inches.

10. A wall that was to be raised 36 ft. high was raised 9 ft. by 16 men in 6 days; how many more must be employed to finish it in 4 days?

11. What fraction is that from which, if there be taken $\frac{2}{9}$ of $\frac{7}{18}$ of $\frac{39}{7}$, and to the remainder there be added $\frac{2}{7}$ of $\frac{9\frac{2}{3}}{2}$, the sum will be 13?

12. A horse cost three times as much as a pony, and a pony four times as much as a saddle, and the price of the saddle is £$\frac{1}{4}$ less than £3; what is the horse worth?

13. The number of letters posted in London was 6430000. Of these 7 per cent. were unpaid; and of the paid letters 75 per cent. were stamped. What was the number of stamped letters?

14. If one tap will empty a cistern in 15 minutes and another fill it in 8 minutes, and both be opened when the cistern is empty, in how many minutes will it be filled?

15. If 1 lb. avoirdupois be equal to 7000 grs. troy, and 66 shillings weigh 1 lb. troy, find the value of 20 avoirdupois ounces of silver.

PAPER No. 85.

1. If 14 yds. of cloth be worth 20 lbs. of sugar, and 45 lbs. of sugar be worth $13\frac{1}{4}$ lbs. of tea, and tea cost 3*s.* 6*d.* per lb., what is the value of $7\frac{1}{2}$ dozen yards of cloth?

3. A person who has £2,954 in the 3 per cents. at $80\frac{1}{2}$, transfers his capital into the 4 per cents. at 98; find the alteration in his income.

3. Bought 612 gallons of oil for £315, and lost 112 gallons; at how much per gallon must I sell the remainder to retrieve the loss, and also clear £8 15*s.*?

4. Find the difference between $\frac{5}{6}$ of $\frac{9}{10}$ of $\frac{17}{18}$ of 10*s.*, and $\frac{1}{7}$ of $\frac{2}{3}$ of £3 11*s.* 9*d.*

5. If 100 men in 6 days of ten hours each can dig a trench 200 yds. long, 3 wide, and 2 deep, in how many days of 8 hours long will 180 men dig a trench of 360 yds. long, 4 wide, and 3 deep?

6. If I buy 14 sheep for £39 6*s.* $5\frac{1}{2}$*d.*, and sell six of them at 36*s.* each, for what must the remainder be sold that I may gain 4 per cent. on the whole?

7. If 3 men or 4 women can do a piece of work in 56 days, in what time will one man and one woman (working together) do it?

8. A chronometer, which is 10 minutes fast on Tuesday at noon, loses 2 min. 11·5 sec. a day; what time will it show at 5 A.M. on the following Saturday?

9. The true length of the year being 365·24224 days,

find to what the error amounts in four centuries, by the reckoning of $365\frac{1}{4}$ days to the year.

10. If a person buys 33 lbs. of tea for £10, and retails it at 6*s.* 8*d.* per pound, what does he gain per cent.?

11. If 14 masons can erect a wall in $20\frac{5}{8}$ days of $9\frac{3}{5}$ hours each, how long would it take 9 masons to do $2\frac{3}{4}$ times the same work, reckoning 12 hours to the day?

12. A person buys 2 cwt. $17\frac{1}{2}$ lbs. of a certain article, for which he pays £5 per cwt.; but, in consequence of its being damaged, the price is afterwards reduced to 8*d.* per pound: how much money will be returned to him?

13. If by selling a chronometer for £40 I lose 20 per cent., what ought I to sell it for to gain 10 per cent.?

14. Add together $\frac{15\frac{2}{3}}{7\frac{4}{3}}$ of £2, $\frac{4}{15}$ of £140 10*s.* 6*d.*, and $\frac{3}{5}$ of 4*s.* 2*d.*

15. A boat moves at the rate of 14 miles per hour in still water, and is accelerated by the current $2\frac{1}{2}$ miles per hour in going down stream, and retarded the same in coming up. In performing a certain distance she was 10 hours longer coming up stream than in going down: what was the distance?

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